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Zuev et al.

(10) **Patent No.: US 9,098,489 B2**
(45) **Date of Patent: Aug. 4, 2015**

(54) **METHOD AND SYSTEM FOR SEMANTIC SEARCHING**

(75) Inventors: **Konstantin Zuev**, Moscow (RU); **Alexander Rylov**, Moscow (RU)

(73) Assignee: **ABBYY InfoPoisk LLC** (RU)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 475 days.

(21) Appl. No.: **13/173,369**

(22) Filed: **Jun. 30, 2011**

(65) **Prior Publication Data**

US 2011/0257963 A1 Oct. 20, 2011

Related U.S. Application Data

(63) Continuation-in-part of application No. 12/983,220, filed on Dec. 31, 2010, which is a continuation-in-part of application No. 11/548,214, filed on Oct. 10, 2006, now Pat. No. 8,078,450.

(51) **Int. Cl.**
G06F 17/27 (2006.01)
G06F 17/30 (2006.01)

(52) **U.S. Cl.**
CPC ***G06F 17/2785*** (2013.01); ***G06F 17/2775*** (2013.01); ***G06F 17/30684*** (2013.01)

(58) **Field of Classification Search**
CPC G06F 17/30864; G06F 17/3087
USPC 704/8–9; 707/705, 708, 711, 713, 736, 707/760
See application file for complete search history.

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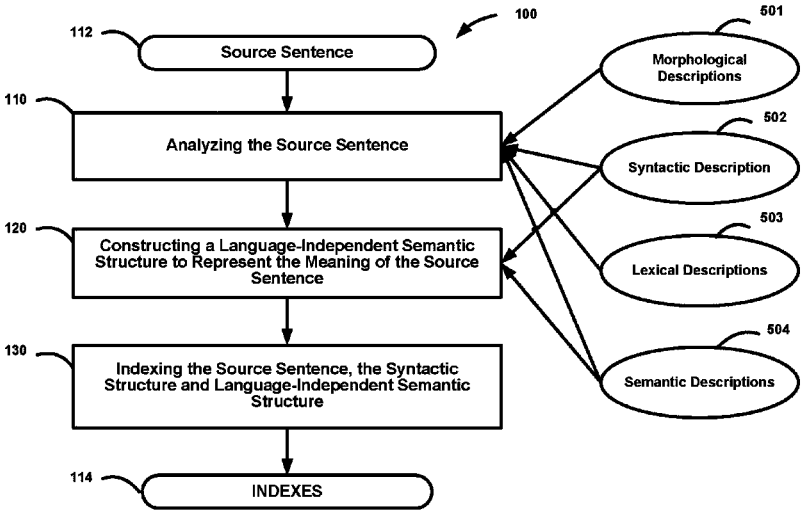
(Continued)

Primary Examiner — Shaun Roberts
(74) *Attorney, Agent, or Firm* — LeighAnn Weiland; Veronica Weinstein

(57) **ABSTRACT**

A method comprising a preliminary automated analysis of at least one corpus of natural language text is disclosed. For each sentence of a corpus, the method includes performing a syntactic analysis using linguistic descriptions to generate at least one syntactic structure for the sentence, building a semantic structure for the sentence, associating each generated syntactic and semantic structure with the sentence, and saving each structure. For each corpus text that was preliminary analyzed, performing an indexing operation to index lexical meanings and values of linguistic parameters of each syntactic structure and each semantic structure associated with sentences in the corpus text. A semantic search includes at least one automatic preliminary analyzed corpus of sentences comprising searched values of linguistic, syntactic and semantic parameters. Due to a deep semantic analysis of a corpus, the search may be executed in various languages, in resources of various languages, and in the text of corpora of various languages regardless of the language of the query.

46 Claims, 15 Drawing Sheets



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2012/0296897	A1		11/2012	Xin-Jing et al.
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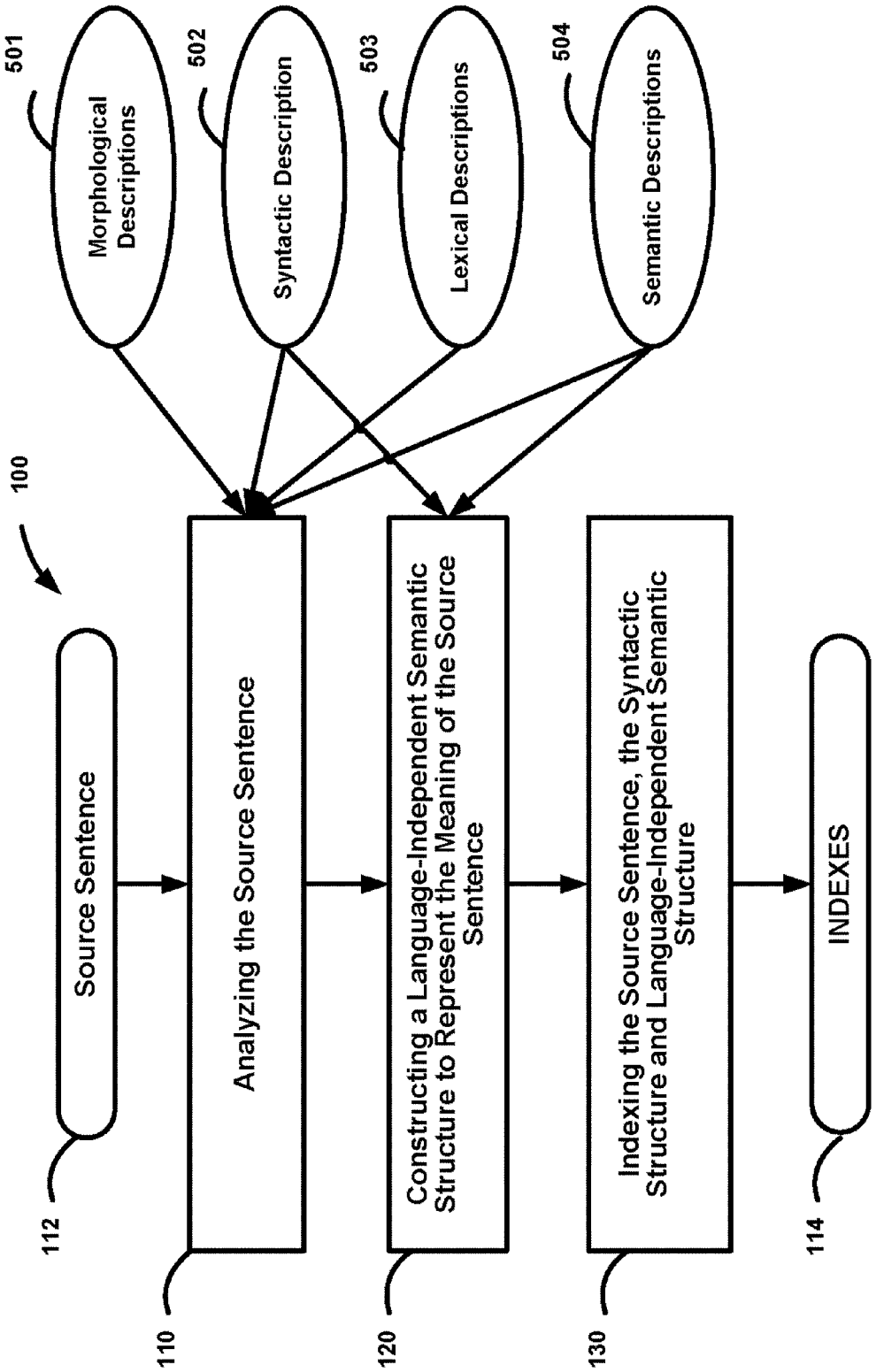
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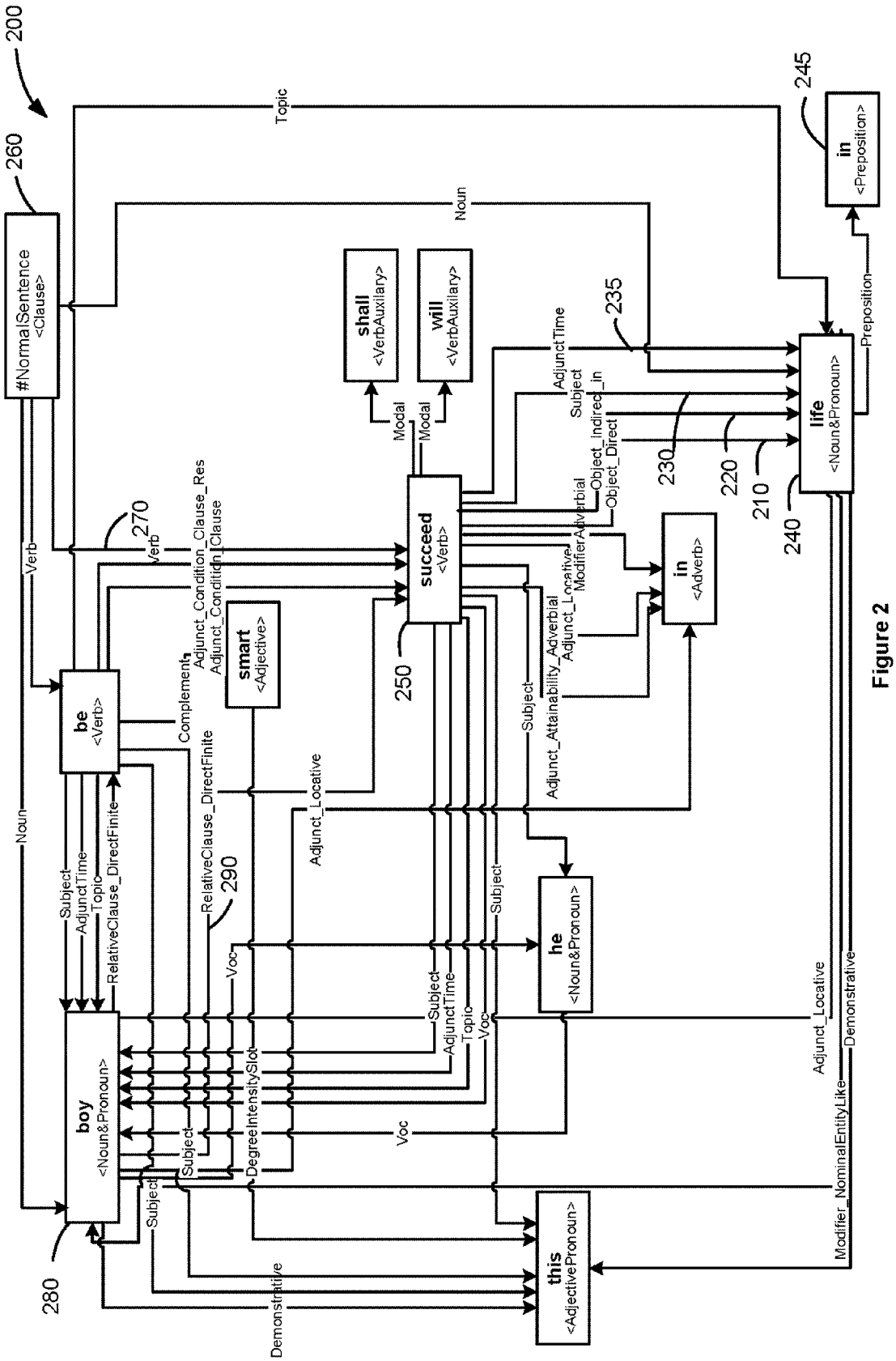
Morphological Descriptions
502
Syntactic Description
503
Lexical Descriptions
504
Semantic Descriptions
100
Source Sentence
112
Analyzing the Source Sentence
110
Constructing a Language-Independent Semantic Structure to Represent the Meaning of the Source Sentence
120
Indexing the Source Sentence, the Syntactic Structure and Language-Independent Semantic Structure
130
INDEXES
114

Figure 1


200
260
#NormalSentence
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Topic
Noun
245
in
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Preposition
shall
<VerbAuxiliary>
will
<VerbAuxiliary>
Modal
Modal
235
AdjunctTime
Subject
Object_Indirect_in
Object_Direct
230
220
210
240
life
<Noun&Pronoun>
succeed
<Verb>
250
Verb
270
Verb
Adjunct_Condition_Clause_Res
Adjunct_Condition_Clause
smart
<Adjective>
Complement
be
<Verb>
Noun
Subject
AdjunctTime
Topic
RelativeClause_DirectFinite
RelativeClause_DirectFinite
290
Adjunct_Locative
Adjunct_Attainability_Adverbial
Adjunct_Locative
ModifierAdverbial
in
<Adverb>
Subject
Voc
he
<Noun&Pronoun>
Subject
AdjunctTime
Topic
Voc
Subject
Voc
DegreeIntensitySlot
Subject
boy
<Noun&Pronoun>
280
Subject
Demonstrative
this
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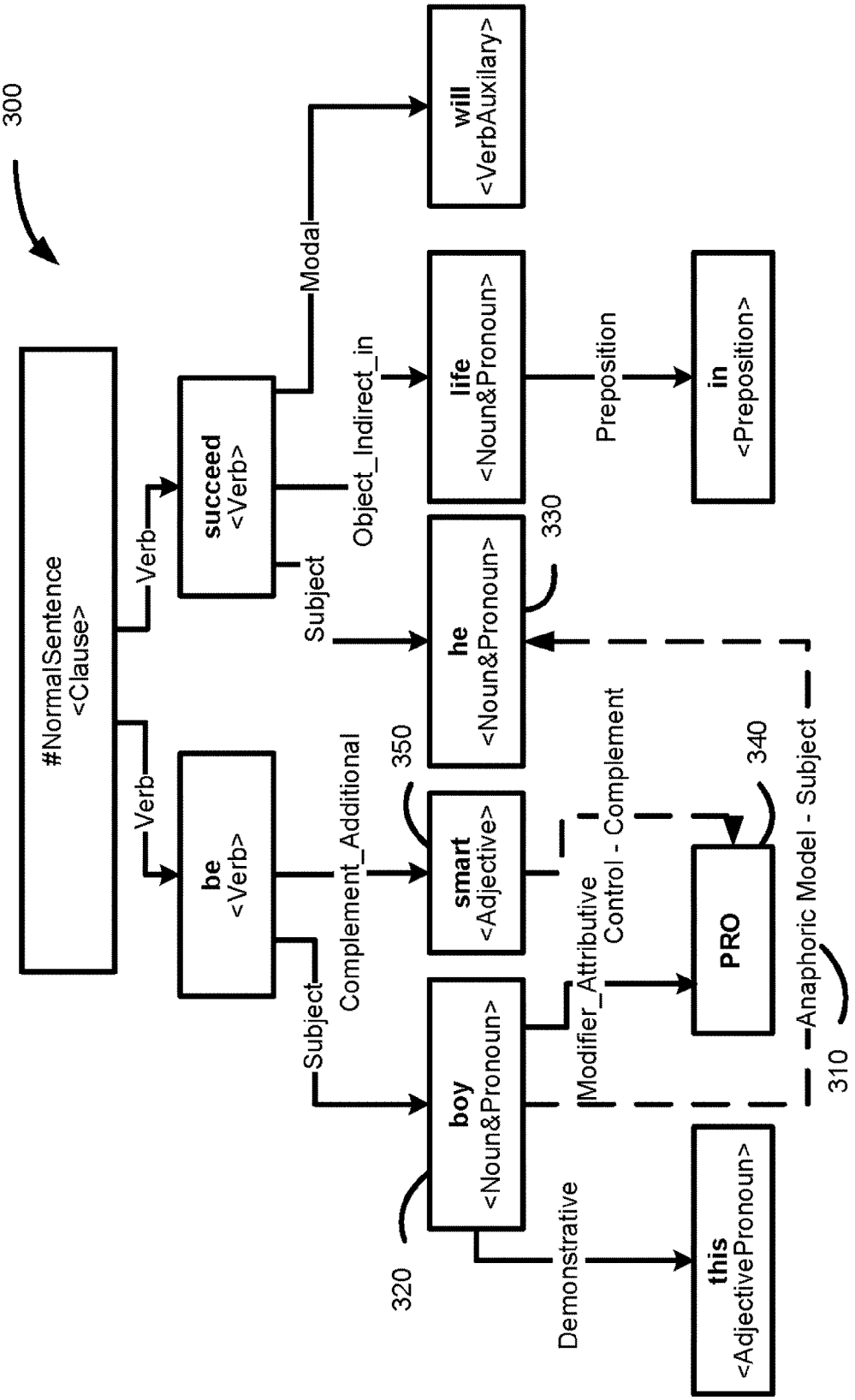
Adjunct_Locative
Demonstrative
Modifier_NominalEntityLike

Figure 2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Verb
Verb
Verb
succeed
<Verb>
be
<Verb>
Modal
will
<VerbAuxilary>
Subject
Object_Indirect_in
life
<Noun&Pronoun>
Preposition
in
<Preposition>
Subject
he
<Noun&Pronoun>
330
Complement_Additional
350
smart
<Adjective>
Control - Complement
340
Subject
boy
<Noun&Pronoun>
Modifier_Attributive
PRO
Anaphoric Model - Subject
310
320
Demonstrative
this
<AdjectivePronoun>

Figure 3

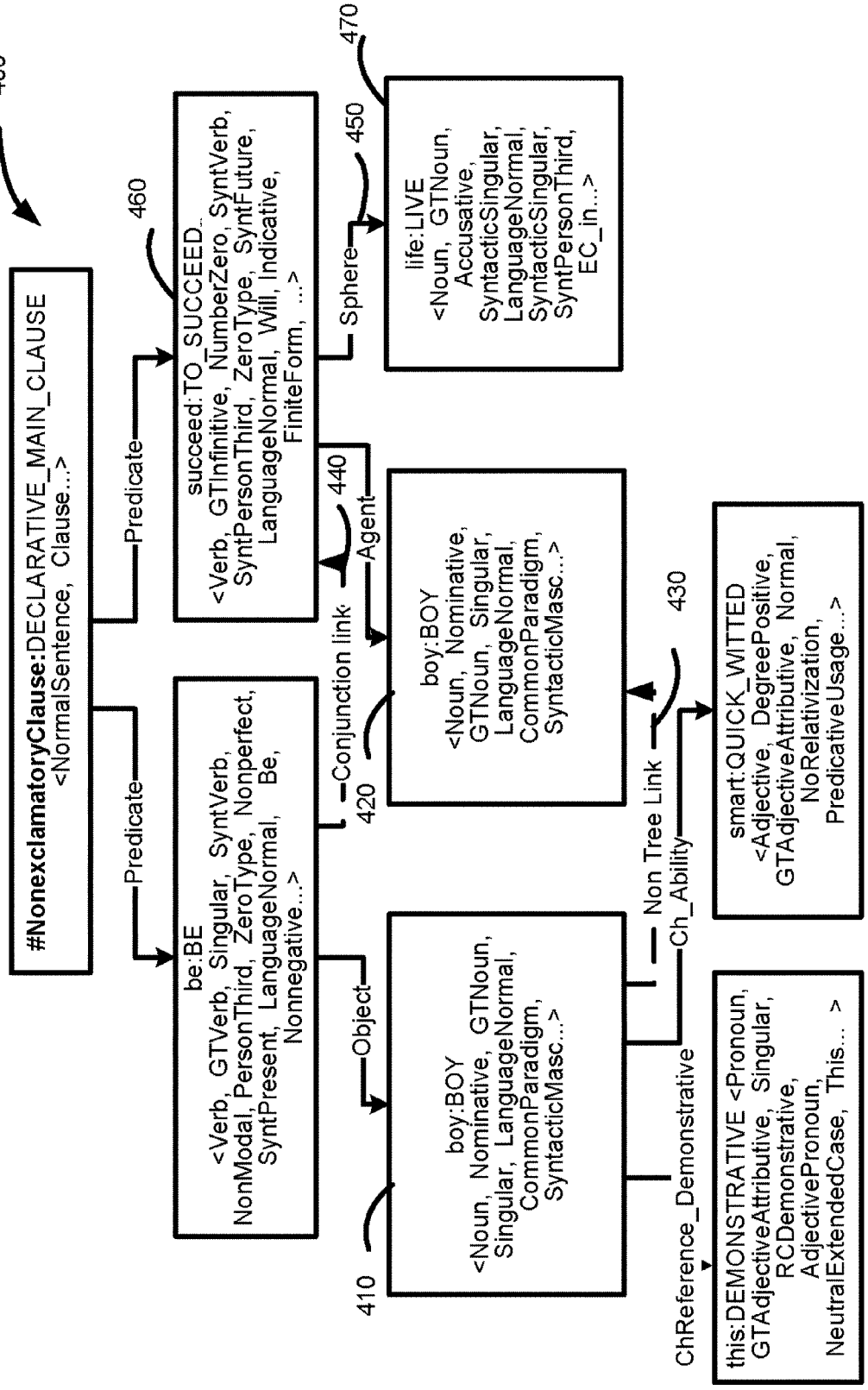

400
#NonexclamatoryClause:DECLARATIVE_MAIN_CLAUSE
<NormalSentence, Clause...>
Predicate
Predicate
460
succeed:TO_SUCCEED
<Verb, GTInfinitive, NumberZero, SyntVerb, SyntPersonThird, ZeroType, SyntFuture, LanguageNormal, Will, Indicative, FiniteForm, ...>
Sphere
450
470
life:LIVE
<Noun, GTNoun, Accusative, SyntacticSingular, LanguageNormal, SyntacticSingular, SyntPersonThird, EC_in...>
be:BE
<Verb, GTVerb, Singular, SyntVerb, NonModal, PersonThird, ZeroType, Nonperfect, SyntPresent, LanguageNormal, Be, Nonnegative...>
Conjunction link
440
Agent
420
boy:BOY
<Noun, Nominative, GTNoun, Singular, LanguageNormal, CommonParadigm, SyntacticMasc...>
Object
410
boy:BOY
<Noun, Nominative, GTNoun, Singular, LanguageNormal, CommonParadigm, SyntacticMasc...>
Non Tree Link
430
Ch_Ability
smart:QUICK_WITTED
<Adjective, DegreePositive, GTAdjectiveAttributive, Normal, NoRelativization, PredicativeUsage...>
ChReference_Demonstrative
this:DEMONSTRATIVE <Pronoun, GTAdjectiveAttributive, Singular, RCDemonstrative, AdjectivePronoun, NeutralExtendedCase, This... >

Figure 4

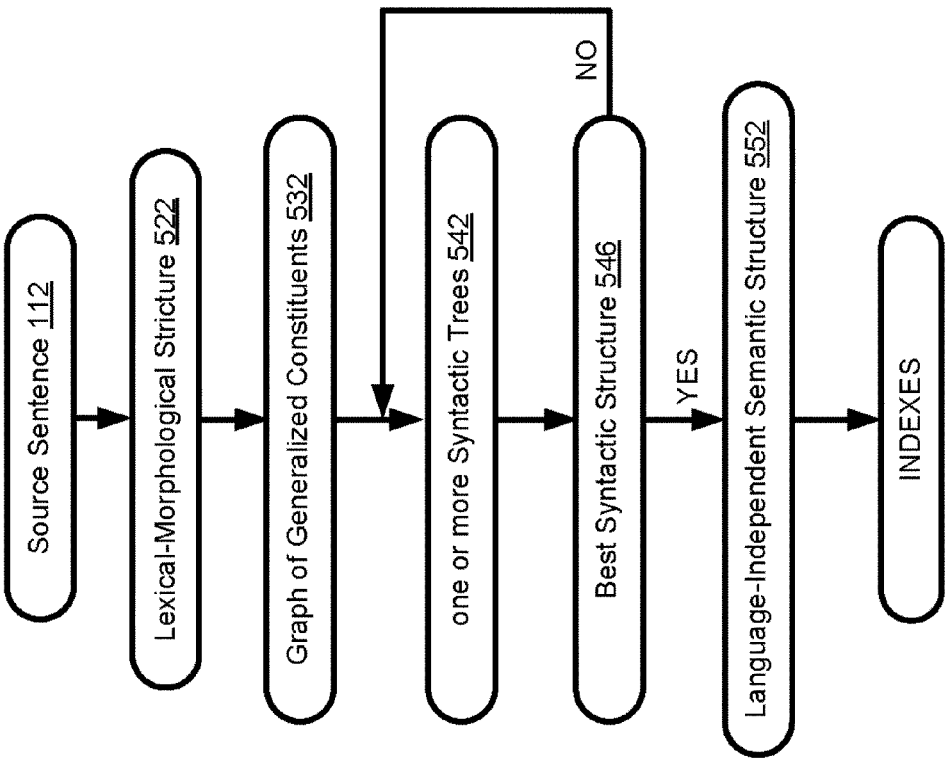
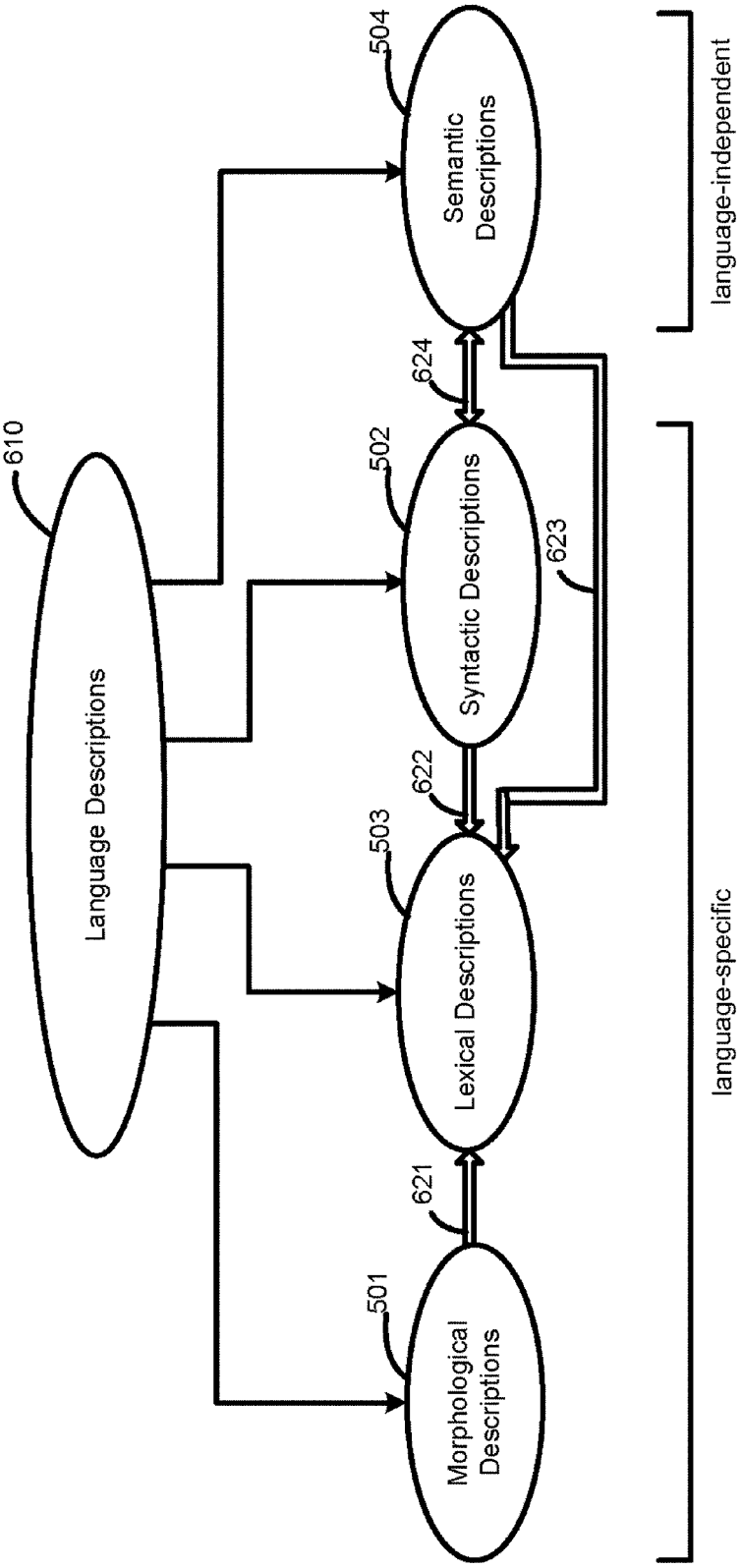

Source Sentence 112
Lexical-Morphological Stricture 522
Graph of Generalized Constituents 532
one or more Syntactic Trees 542
Best Syntactic Structure 546
NO
YES
Language-Independent Semantic Structure 552
INDEXES

Figure 5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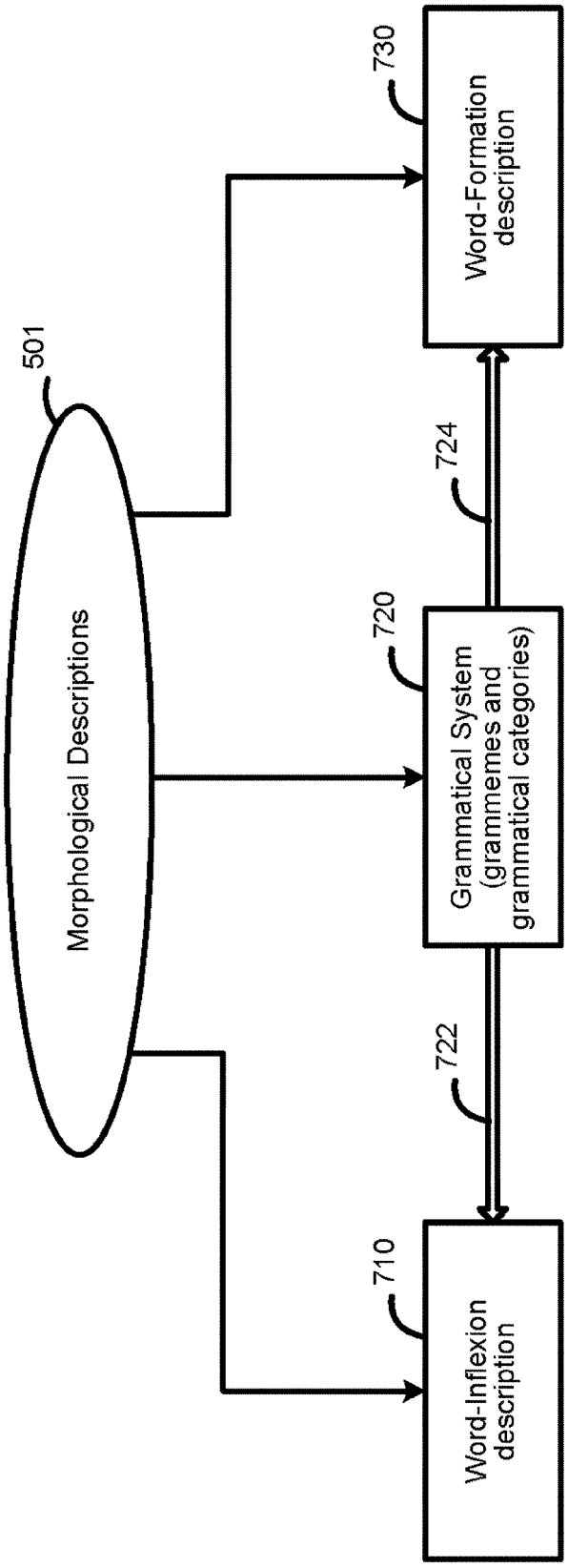
Language Descriptions
504
Semantic Descriptions
624
502
Syntactic Descriptions
623
622
503
Lexical Descriptions
621
501
Morphological Descriptions
language-independent
language-specific

Figure 6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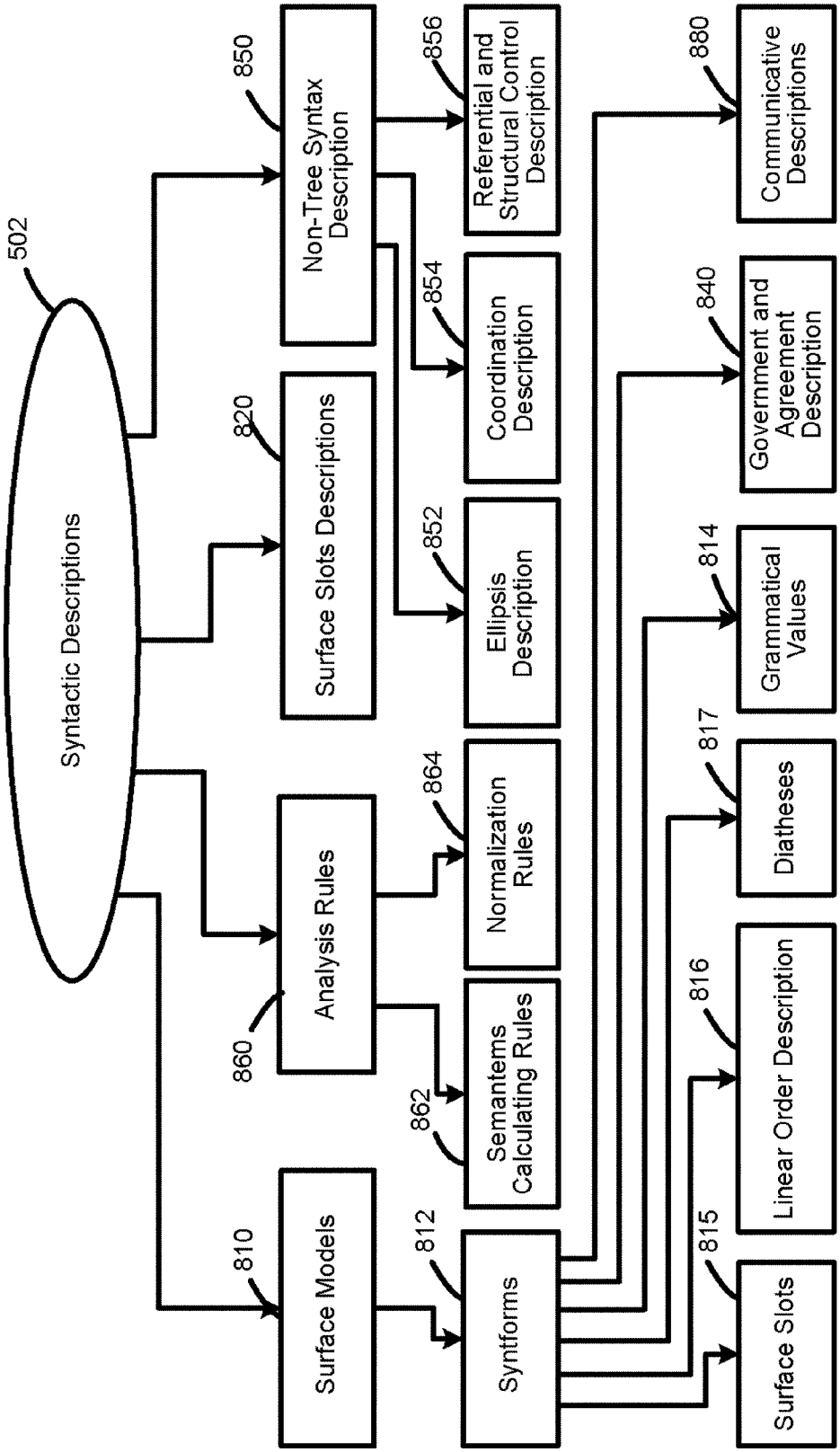
Morphological Descriptions
730
Word-Formation description
724
720
Grammatical System (grammemes and grammatical categories)
722
710
Word-Inflexion description

Figure 7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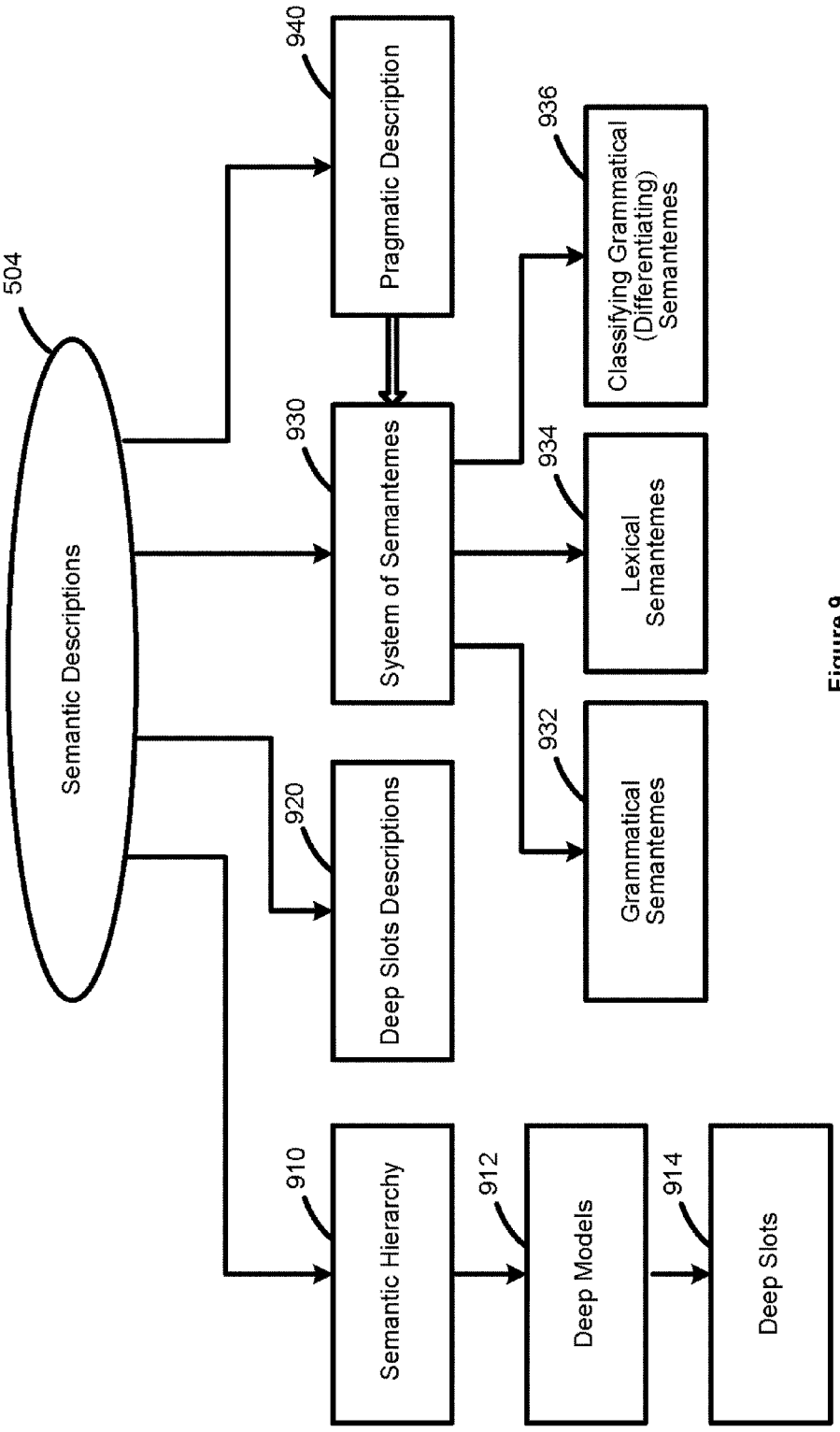
Syntactic Descriptions
850
Non-Tree Syntax Description
856
Referential and Structural Control Description
880
Communicative Descriptions
820
Surface Slots Descriptions
854
Coordination Description
840
Government and Agreement Description
852
Ellipsis Description
814
Grammatical Values
860
Analysis Rules
864
Normalization Rules
817
Diatheses
862
Semantems Calculating Rules
816
Linear Order Description
810
Surface Models
812
Syntforms
815
Surface Slots

Figure 8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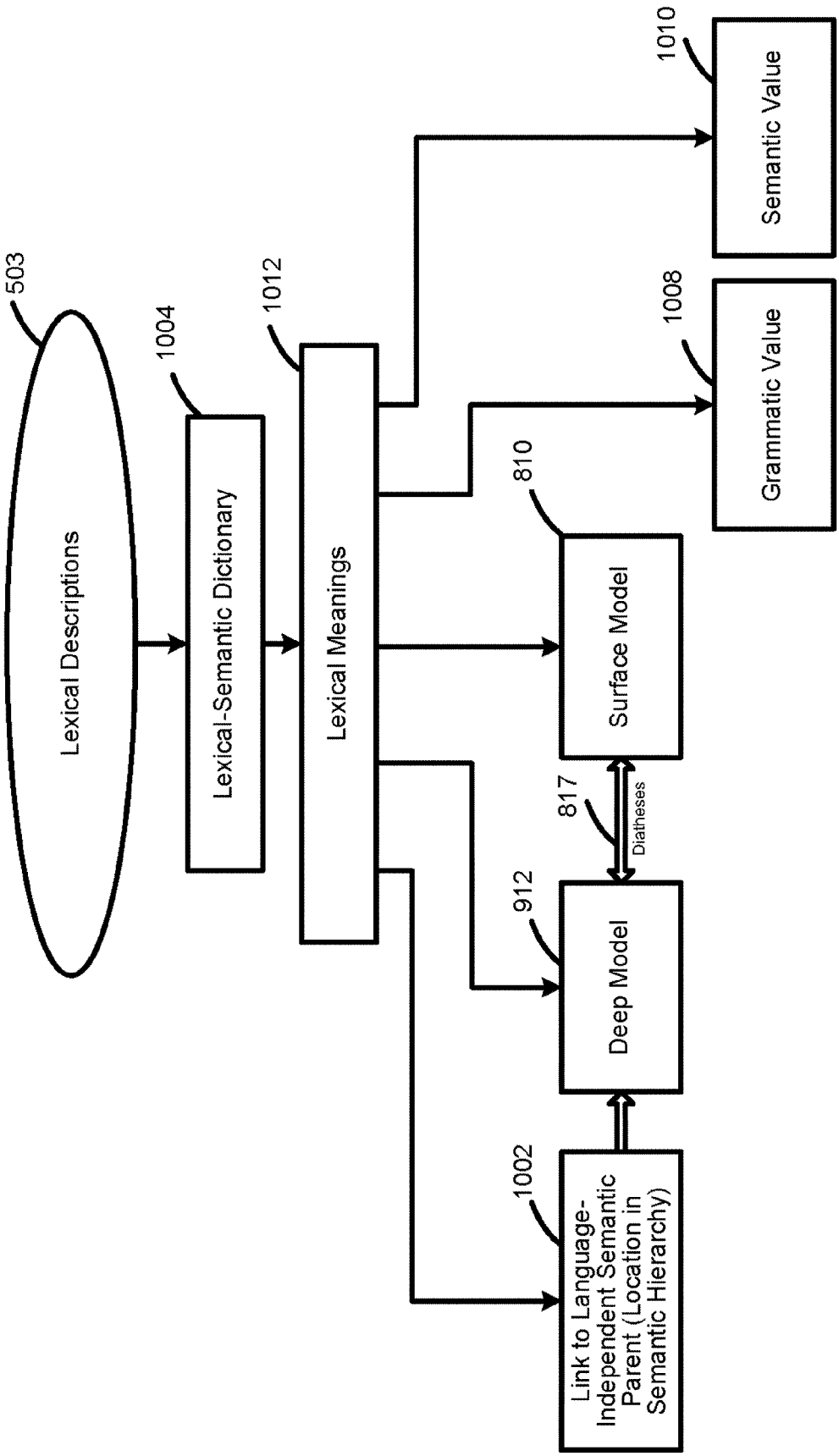
Semantic Descriptions
940
Pragmatic Description
930
System of Semantemes
936
Classifying Grammatical (Differentiating) Semantemes
934
Lexical Semantemes
932
Grammatical Semantemes
920
Deep Slots Descriptions
910
Semantic Hierarchy
912
Deep Models
914
Deep Slots

Figure 9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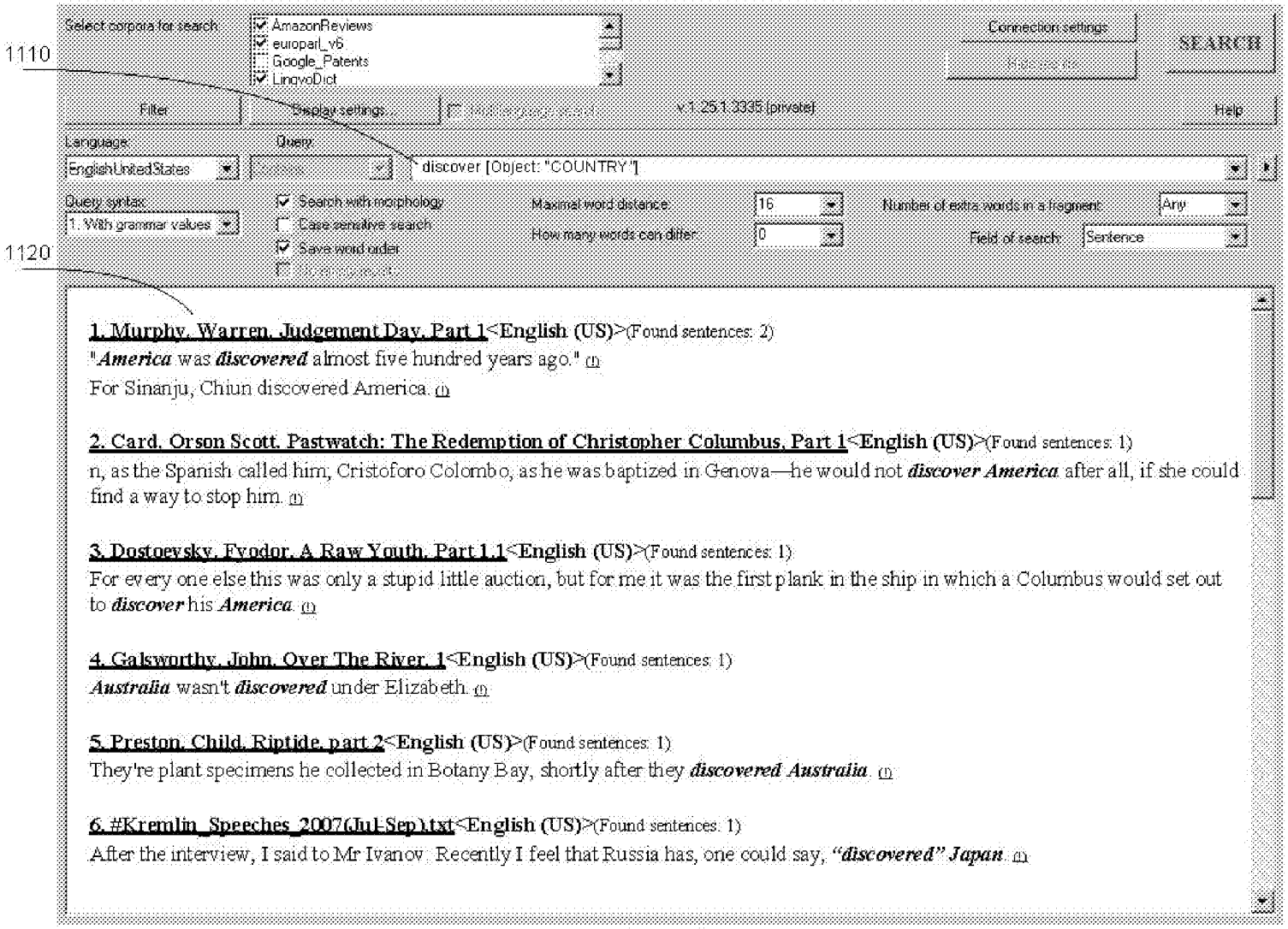
Lexical Descriptions
1004
Lexical-Semantic Dictionary
1012
Lexical Meanings
1010
Semantic Value
1008
Grammatic Value
810
Surface Model
817
Diatheses
912
Deep Model
1002
Link to Language-Independent Semantic Parent (Location in Semantic Hierarchy)

Figure 10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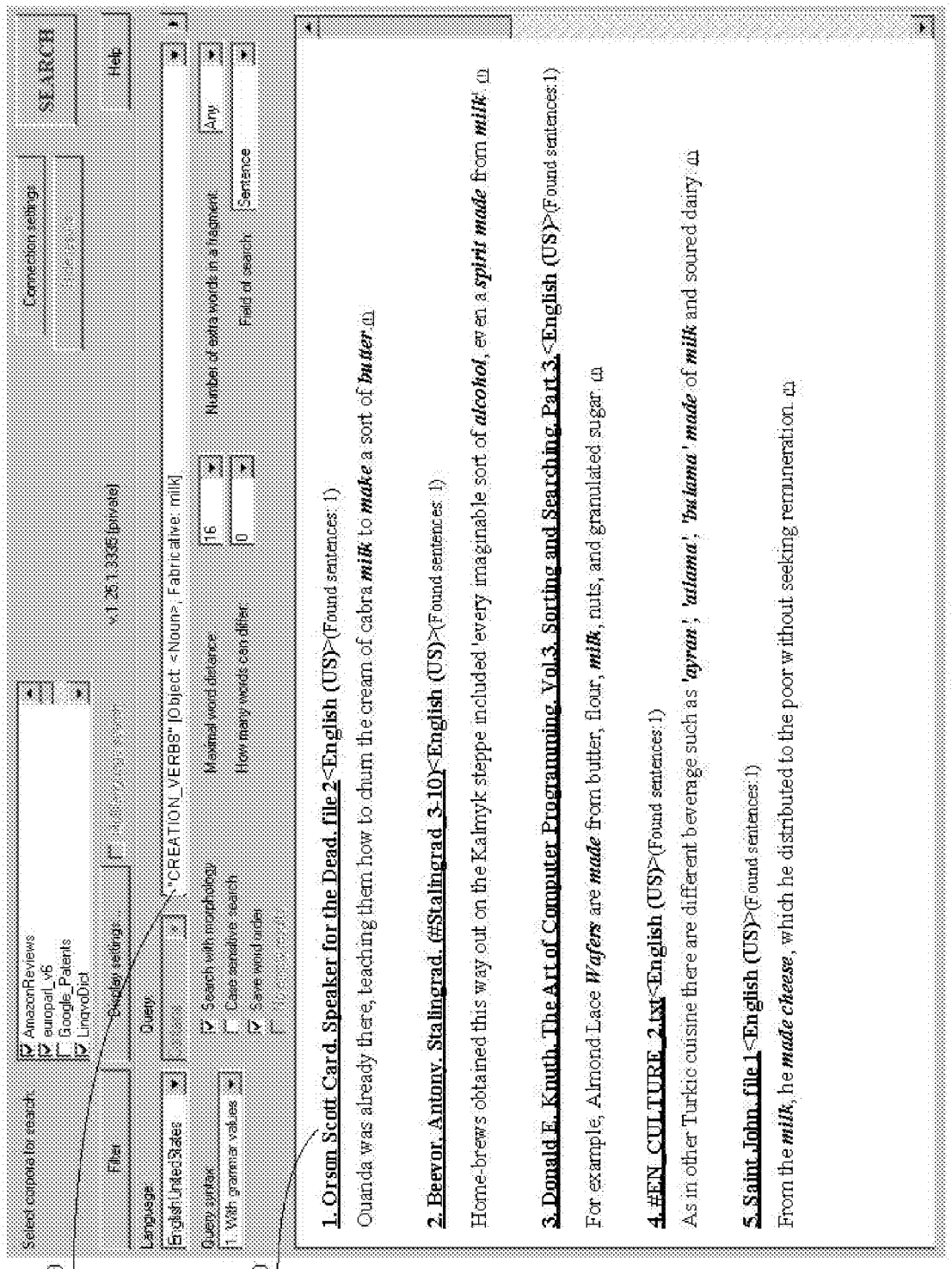
Query syntax:
1. With grammar values
Search with morphology
Case sensitive search
Save word order
Maximal word distance:
16
How many words can differ:
0
Number of extra words in a fragment:
Any
Field of search:
Sentence
1. Murphy, Warren, Judgement Day, Part 1<English (US)>(Found sentences: 2)
"America was discovered almost five hundred years ago." (1)
For Sinanju, Chiun discovered America. (1)
2. Card, Orson Scott, Pastwatch: The Redemption of Christopher Columbus, Part 1<English (US)>(Found sentences: 1)
n, as the Spanish called him, Cristoforo Colombo, as he was baptized in Genova—he would not discover America after all, if she could find a way to stop him. (1)
3. Dostoevsky, Fyodor, A Raw Youth, Part 1.1<English (US)>(Found sentences: 1)
For every one else this was only a stupid little auction, but for me it was the first plank in the ship in which a Columbus would set out to discover his America. (1)
4. Galsworthy, John, Over The River, 1<English (US)>(Found sentences: 1)
Australia wasn't discovered under Elizabeth. (1)
5. Preston, Child, Riptide, part 2<English (US)>(Found sentences: 1)
They're plant specimens he collected in Botany Bay, shortly after they discovered Australia. (1)
6. #Kremlin_Speeches_2007(Jul-Sep).txt<English (US)>(Found sentences: 1)
After the interview, I said to Mr Ivanov: Recently I feel that Russia has, one could say, "discovered" Japan. (1)

Figure 11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"CREATION_VERBS" [Object: <Noun>; Fabricative: milk]
Query syntax:
1. With grammar values
Search with morphology
Case sensitive search
Save word order
Maximal word distance:
16
How many words can differ:
0
Number of extra words in a fragment:
Any
Field of search:
Sentence
1. Orson Scott Card. Speaker for the Dead. file 2<English (US)>(Found sentences: 1)
Ouanda was already there, teaching them how to churn the cream of cabra milk to make a sort of butter.
2. Beevor, Antony. Stalingrad. (#Stalingrad_3-10)<English (US)>(Found sentences: 1)
Home-brews obtained this way out on the Kalmyk steppe included 'every imaginable sort of alcohol, even a spirit made from milk'.
3. Donald E. Knuth. The Art of Computer Programming. Vol.3. Sorting and Searching. Part 3.<English (US)>(Found sentences:1)
For example, Almond Lace Wafers are made from butter, flour, milk, nuts, and granulated sugar.
4. #EN_CULTURE_2.txt<English (US)>(Found sentences:1)
As in other Turkic cuisine there are different beverage such as 'ayran', 'atlama', 'bulama' made of milk and soured dairy.
5. Saint John. file 1<English (US)>(Found sentences:1)
From the milk, he made cheese, which he distributed to the poor without seeking remuneration.

Figure 12

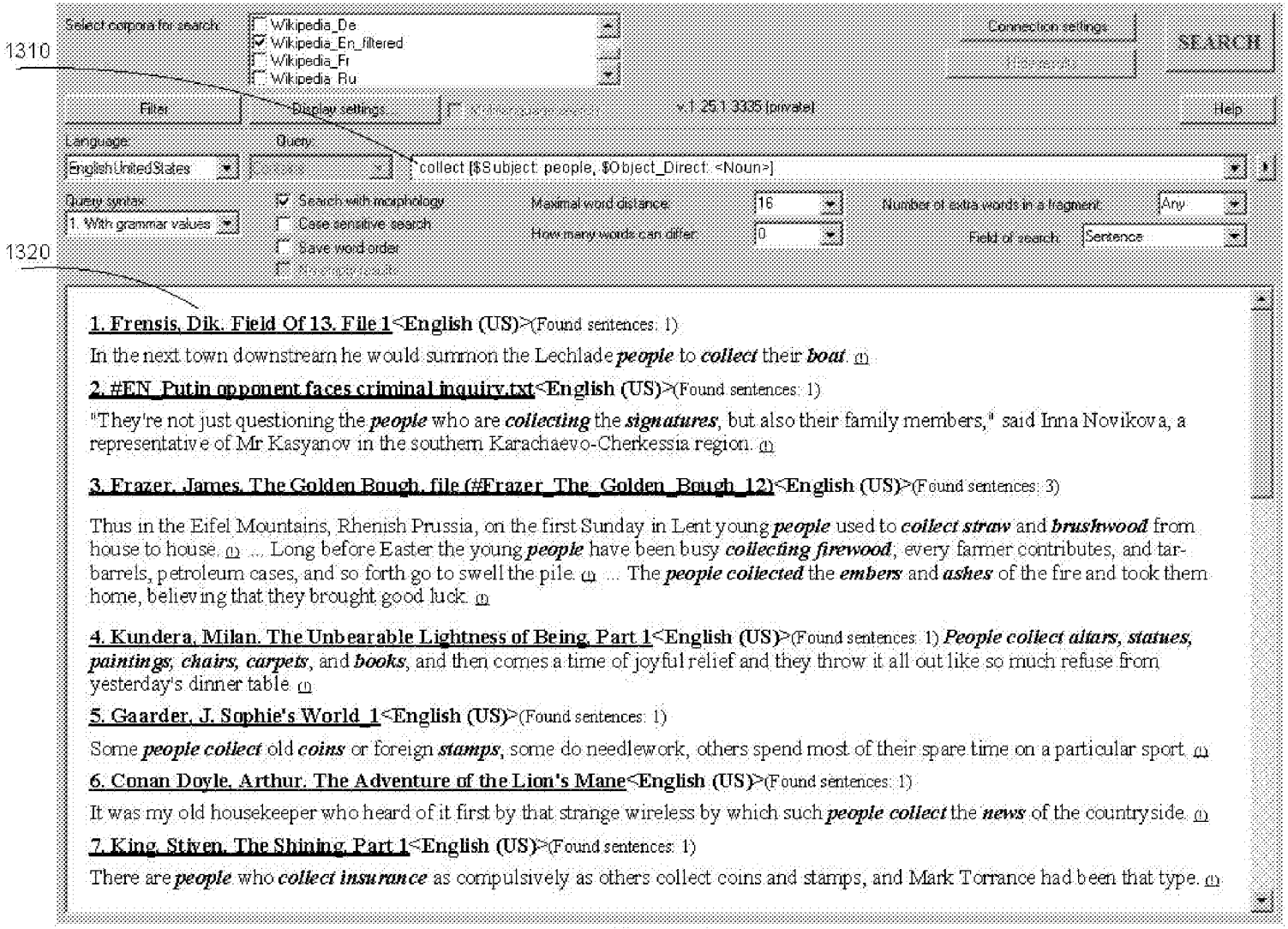
1310
1320
Select corpora for search:
Wikipedia_De
Wikipedia_En_filtered
Wikipedia_Fr
Wikipedia_Ru
Connection settings
SEARCH
Filter
Display settings
v.1.25.1.3335 (private)
Help
Language:
Query:
English/United States
collect [$Subject: people, $Object_Direct: <Noun>]
Query syntax:
1. With grammar values
Search with morphology
Case sensitive search
Save word order
Maximal word distance:
16
How many words can differ:
0
Number of extra words in a fragment:
Any
Field of search:
Sentence
1. Frensis, Dik. Field Of 13. File 1<English (US)>(Found sentences: 1)
In the next town downstream he would summon the Lechlade people to collect their boat.
2. #EN_Putin opponent faces criminal inquiry.txt<English (US)>(Found sentences: 1)
"They're not just questioning the people who are collecting the signatures, but also their family members," said Inna Novikova, a representative of Mr Kasyanov in the southern Karachaevo-Cherkessia region.
3. Frazer, James. The Golden Bough, file (#Frazer_The_Golden_Bough_12)<English (US)>(Found sentences: 3)
Thus in the Eifel Mountains, Rhenish Prussia, on the first Sunday in Lent young people used to collect straw and brushwood from house to house. ... Long before Easter the young people have been busy collecting firewood, every farmer contributes, and tar-barrels, petroleum cases, and so forth go to swell the pile. ... The people collected the embers and ashes of the fire and took them home, believing that they brought good luck.
4. Kundera, Milan. The Unbearable Lightness of Being, Part 1<English (US)>(Found sentences: 1) People collect altars, statues, paintings, chairs, carpets, and books, and then comes a time of joyful relief and they throw it all out like so much refuse from yesterday's dinner table.
5. Gaarder, J. Sophie's World_1<English (US)>(Found sentences: 1)
Some people collect old coins or foreign stamps, some do needlework, others spend most of their spare time on a particular sport.
6. Conan Doyle, Arthur. The Adventure of the Lion's Mane<English (US)>(Found sentences: 1)
It was my old housekeeper who heard of it first by that strange wireless by which such people collect the news of the countryside.
7. King, Stiven. The Shining, Part 1<English (US)>(Found sentences: 1)
There are people who collect insurance as compulsively as others collect coins and stamps, and Mark Torrance had been that type.

Figure 13

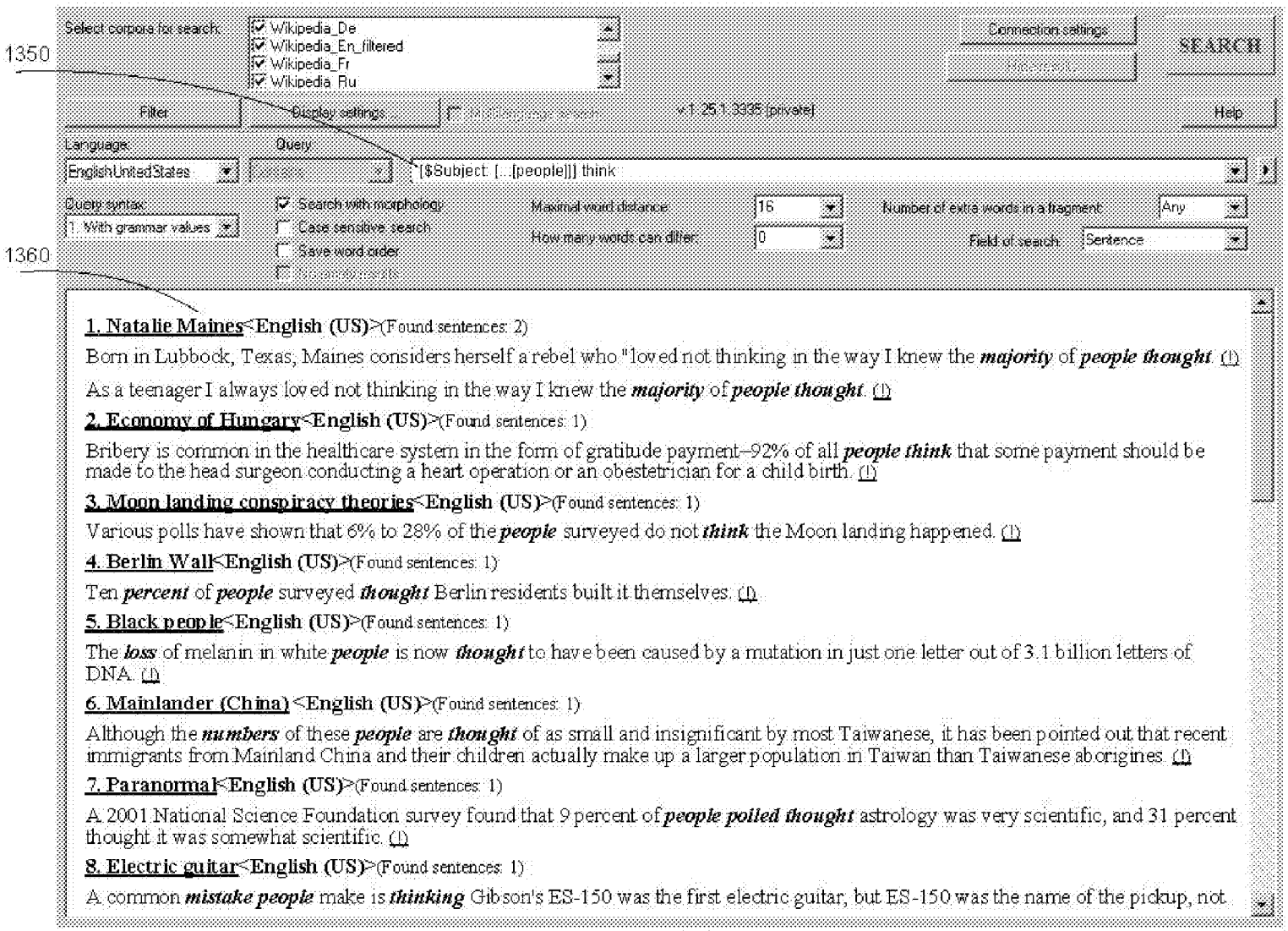
1350
1360
Select corpora for search:
Wikipedia_De
Wikipedia_En_filtered
Wikipedia_Fr
Wikipedia_Ru
Connection settings
SEARCH
Filter
Display settings
v.1.25.1.3335 [private]
Help
Language:
Query
EnglishUnitedStates
[$Subject: [...[people]]] think
Query syntax:
1. With grammar values
Search with morphology
Case sensitive search
Save word order
Maximal word distance:
16
How many words can differ:
0
Number of extra words in a fragment:
Any
Field of search:
Sentence
1. Natalie Maines<English (US)>(Found sentences: 2)
Born in Lubbock, Texas, Maines considers herself a rebel who "loved not thinking in the way I knew the majority of people thought. (1)
As a teenager I always loved not thinking in the way I knew the majority of people thought. (1)
2. Economy of Hungary<English (US)>(Found sentences: 1)
Bribery is common in the healthcare system in the form of gratitude payment–92% of all people think that some payment should be made to the head surgeon conducting a heart operation or an obestetrician for a child birth. (1)
3. Moon landing conspiracy theories<English (US)>(Found sentences: 1)
Various polls have shown that 6% to 28% of the people surveyed do not think the Moon landing happened. (1)
4. Berlin Wall<English (US)>(Found sentences: 1)
Ten percent of people surveyed thought Berlin residents built it themselves. (1)
5. Black people<English (US)>(Found sentences: 1)
The loss of melanin in white people is now thought to have been caused by a mutation in just one letter out of 3.1 billion letters of DNA. (1)
6. Mainlander (China)<English (US)>(Found sentences: 1)
Although the numbers of these people are thought of as small and insignificant by most Taiwanese, it has been pointed out that recent immigrants from Mainland China and their children actually make up a larger population in Taiwan than Taiwanese aborigines. (1)
7. Paranormal<English (US)>(Found sentences: 1)
A 2001 National Science Foundation survey found that 9 percent of people polled thought astrology was very scientific, and 31 percent thought it was somewhat scientific. (1)
8. Electric guitar<English (US)>(Found sentences: 1)
A common mistake people make is thinking Gibson's ES-150 was the first electric guitar, but ES-150 was the name of the pickup, not

Figure 13A

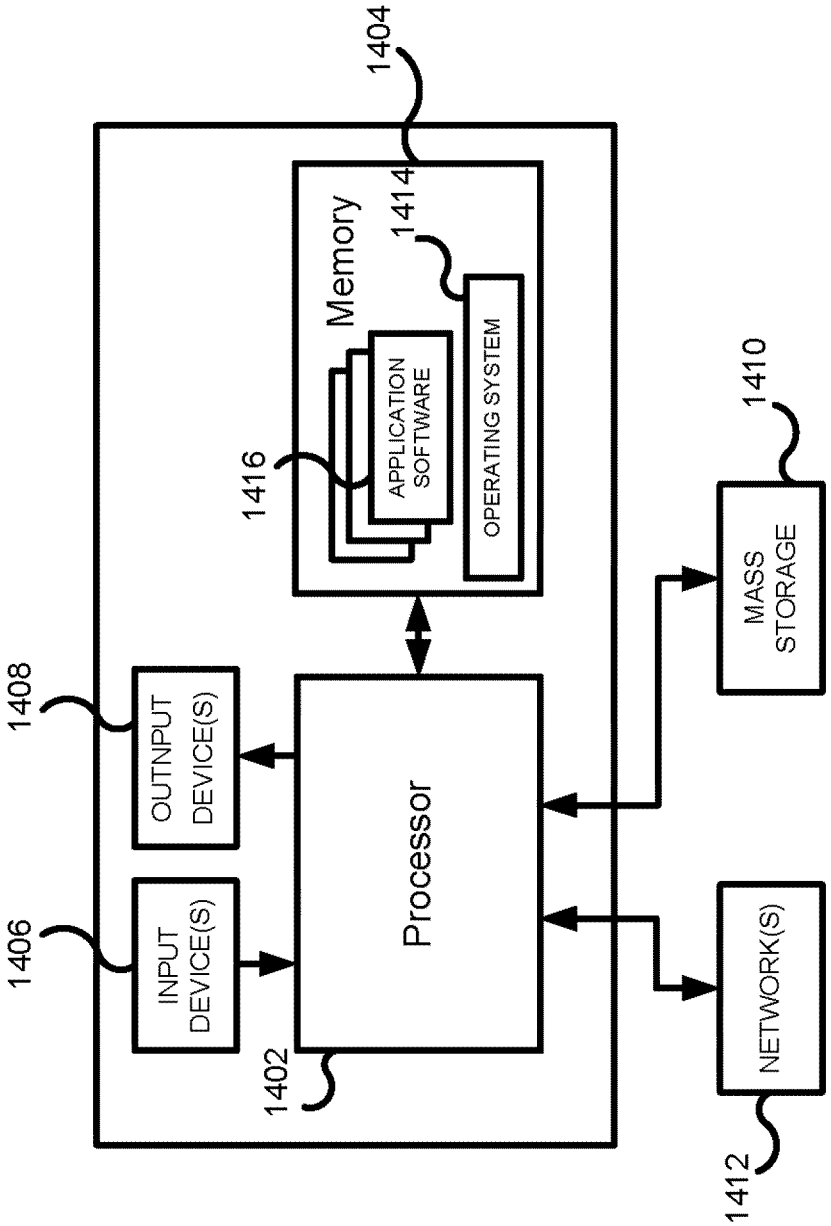
1404
Memory
1414
APPLICATION SOFTWARE
OPERATING SYSTEM
1416
1408
OUTNPUT DEVICE(S)
1406
INPUT DEVICE(S)
Processor
1402
1410
MASS STORAGE
NETWORK(S)
1412

Figure 14

METHOD AND SYSTEM FOR SEMANTIC SEARCHING

CROSS-REFERENCE TO RELATED APPLICATIONS

For purposes of the USPTO extra-statutory requirements, the present application constitutes a continuation-in-part of U.S. patent application Ser. No. 12/983,220, filed on 31 Dec. 2010, which is a continuation-in-part of U.S. Ser. No. 11/548,214, filed on 10 Oct. 2006 now U.S. Pat. No. 8,078,450.

The United States Patent Office (USPTO) has published a notice effectively stating that the USPTO's computer programs require that patent applicants reference both a serial number and indicate whether an application is a continuation or continuation-in-part. Stephen G. Kunin, Benefit of Prior-Filed Application, USPTO Official Gazette 18 Mar. 2003. The present Applicant Entity (hereinafter "Applicant") has provided above a specific reference to the application(s) from which priority is being claimed as recited by statute. Applicant understands that the statute is unambiguous in its specific reference language and does not require either a serial number or any characterization, such as "continuation" or "continuation-in-part," for claiming priority to U.S. patent applications. Notwithstanding the foregoing, Applicant understands that the USPTO's computer programs have certain data entry requirements, and hence Applicant is designating the present application as a continuation-in-part of its parent applications as set forth above, but expressly points out that such designations are not to be construed in any way as any type of commentary and/or admission as to whether or not the present application contains any new matter in addition to the matter of its parent application(s).

All subject matter of the Related Applications and of any and all parent, grandparent, great-grandparent, etc. applications of the Related Applications is incorporated herein by reference to the extent such subject matter is not inconsistent herewith.

BACKGROUND OF THE INVENTION

1. Field

Implementations of the present invention relate to search technology. In particular, implementations of the present invention relate to searching of electronic content available, for example, on the Internet and in other electronic resources, such as text corpora, dictionaries, glossaries, encyclopedias, etc.

2. Related Art

The inventors are aware of search technology that generates search results based on keywords entered by a user as part of a search query.

However, due to homonymy and homography in natural languages, a search result based on a keyword search may include a substantial amount of non-relevant or marginally relevant information. For example, if the user searches for texts with the word "page" in the sense of "a man or boy employed as the personal attendant to a queen," the user may receive a large number of non-relevant information where "page" refers to an Internet page, a page of a newspaper or magazine, a section of stored data, etc. This is likely to happen because those other senses of the word "page" are substantially more frequent than the one referring to a man or boy.

Existing search systems make it possible to use simple query languages to find documents that either contain or do not contain the words or word combinations specified by the user. However, the user cannot specify whether the search words should occur within one sentence or not. Also, the user cannot formulate a query for a set of words that belong to a certain class. And finally, existing search systems do not allow users to find sentences based on their syntactic or semantic properties, e.g., examples illustrating a certain syntactic relationship, examples illustrating a semantic relationship, they do not allow to make queries based on grammatical meanings, deep or surface slots, syntactic models, style and/or semantic features, etc. These types of searches may be of use to lexicographers, philologists, linguists, and students and teachers of native or foreign languages, and many other users.

SUMMARY

According to a first aspect of the invention, there is provided a computer-implemented method, comprising:

preliminarily automatic analyzing at least one corpus of natural language texts comprising for each sentence of each natural language text of each corpus, the preliminarily analyzing including:

performing a syntactic analysis using linguistic descriptions to generate at least one syntactic structure for the sentence;

building a semantic structure for the sentence;

associating each generated syntactic and semantic structure with the sentence; and

saving each generated syntactic and semantic structure;

for each corpus of natural language text that was preliminarily analyzed, performing an indexing operation to index lexical meanings and values of linguistic parameters of each syntactic structure and each semantic structure associated with sentences in the respective corpus; and

searching in at least one preliminarily analyzed corpus for sentences comprising a searched value for at least one linguistic parameter or at least one lexical meaning.

According to a second aspect of the invention, there is provided a system for implementing the aforesaid method.

Other aspects of the invention will be apparent from the detailed description below. Generally, the present invention employs a full-fledged automatic syntactic and semantic analysis when indexing texts making it possible to index and store all syntactic and semantic information about each sentence, as well as all interim parsing and results and lexical choices, including results obtained when resolving ambiguities.

An analyzer uses various linguistic descriptions of a given natural language to reflect all the real complexities of the natural language, rather than simplified or artificial descriptions, without the danger of a combinatorial explosion. A principle of integral and purpose-driven recognition, (i.e. hypotheses about the structure of the part of a sentence are verified within the hypotheses about the structure of the whole sentence), is implemented as during the analysis stage. It allows to avoid analyzing numerous parsing of anomalous variants.

The use of the technology described herein allows one to search and find relevant information using a semantic query that can be expressed in specific semantic query language, or in a natural language. The same analyzer is able to analyze a question to recognize its syntactical structure, to build its semantic structure, and in such a way "to understand" the meaning of a query. Searching is implemented in accordance with syntax and semantic information included in or derived from searchable resources. A user receives only relevant search results.

Additionally, since the search query may be expressed or translated into semantic language-independent terms, the search may be executed in and derived from various languages, in resources of various languages, in text corpora of various languages. So, a user can get information that is presented in all resources regardless of the language of the query. The result of searching may be presented to users in a resource language (as it is presented in the resource), and also the result of searching may be translated into the language of the query by means of a machine translation system.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates a flow chart of a method **100** for preprocessing source sentences **112** in a source natural language prior to initiating a search.

FIG. **2** illustrates an example of a graph of generalized constituents obtained as a result of a rough syntactic analysis of the sentence "This boy is smart, he'll succeed in life."

FIG. **3** shows an example of a syntactic tree, obtained as a result of a precise syntactic analysis of the sentence "This boy is smart, he'll succeed in life."

FIG. **4** shows an example of a semantic structure obtained for the sentence "This boy is smart, he'll succeed in life."

FIG. **5** illustrates converting a source sentence into a language independent semantic structure through various structures according to an exemplary implementation of the invention and the linguistic descriptions employed.

FIG. **6** is a diagram illustrating linguistic descriptions according to one exemplary implementation of the invention.

FIG. **7** illustrates exemplary morphological descriptions.

FIG. **8** illustrates exemplary syntactic descriptions.

FIG. **9** is a diagram illustrating semantic descriptions according to one exemplary implementation of the invention.

FIG. **10** is a diagram illustrating lexical descriptions according to one exemplary implementation of the invention.

FIG. **11** shows an example of a search system interface that allows a user to formulate queries using semantic relations and semantic classes or lexical meanings that belong to a certain semantic class instead of conventional key words.

FIG. **12** shows another example of query using semantic relations and semantic classes or lexical meanings that belong to a certain semantic class.

FIG. **13** shows still another example of query using semantic relations and semantic classes or lexical meanings.

FIG. **13**A shows still another example of query using variables for denoting "lacunas" in searched sentences and a possibility of selecting Multilanguage corpora of texts.

FIG. **14** shows exemplary hardware for implementing the searching system using the techniques described in this application, in accordance with an implementation of the present disclosure.

DETAILED DESCRIPTION

In the following description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the invention. It will be apparent, however, to one skilled in the art that the invention can be practiced without these specific details.

Reference in this specification to "one embodiment" or "an implementation" means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one implementation of the invention. The appearances of the phrase "in one embodiment" or "in one implementation" in various places in the specification are not necessarily all referring to the same embodiment or implementation, nor are separate or alternative embodiments mutually exclusive of other embodiments. Moreover, various features are described which may be exhibited by some embodiments and not by others. Similarly, various requirements are described which may be requirements for some embodiments but not other embodiments.

Implementations of the present invention disclose indexing techniques and systems for indexing natural language texts. Sematic search techniques and systems are also disclosed.

Broadly, one indexing technique disclosed herein comprises performing a comprehensive or exhaustive syntactic and semantic analysis of natural language texts to build an index for each natural language text. Advantageously, all syntactic and semantic information about each sentence in the natural language texts generated pursuant to the syntactic and semantic analysis is saved. The saved information may include interim parsing results and lexical choices, including the results obtained when resolving ambiguities.

The index so produced may be used to allow semantic searching of the natural language texts, as will be described later.

The existing search systems make it possible to use simple query languages to find documents that either contain or do not contain the words or word combinations specified by the user. However, the user cannot specify whether the search words should occur within one sentence or not. Also, the user cannot formulate a query for a set of words that belong to a certain class. And finally, the existing search systems do not allow users to find sentences based on their syntactic or semantic properties, e.g. examples illustrating a certain syntactic relationship, examples illustrating a semantic relationship, or searches based on grammatical meanings, deep or surface slots, syntactic models, style and/or semantic features, etc. These types of searches may be of use to lexicographers, philologists, linguists, and students and teachers of native or foreign languages, and many other users.

Advantageously, the problems associated with existing search systems are overcome or at least reduced by the techniques and systems disclosed herein.

Further, implementations of the invention allows a user to search and to find relevant information using a semantic query that can be expressed in specific semantic query language, and also in a natural language. The same analyzer analyzes the question to recognize its syntactical structure, to build its semantic structure, and in such a way "understands" the meaning of the query. Searching is implemented in accordance with syntax and semantic of information which is included in searchable resources. So, a user can get only relevant output.

Additionally, since the search query may be expressed or translated into semantic language-independent terms, the search may be executed in various languages, in resources of various languages, in text corpora of various languages. Thus, a user can get information that is presented in all resources regardless of the language of the query. The result of searching may be presented to users in a resource language (as it is presented in the resource), and also the result of searching may be translated into the language of the query by means of a machine translation system.

Co-pending application U.S. Ser. No. 11/548,214 discloses syntactic and semantic analysis methods (hereinafter "the analysis methods"). The analysis methods may be used to perform the analysis step of the disclosed indexing techniques. The analysis methods use a large number of exhaustive linguistic descriptions of a given natural language to reflect all the real complexities of the natural language, rather than simplified or artificial descriptions, without the danger of

a combinatorial explosion, an unmanageable exponential complexity. Moreover, the analysis methods are based on a principle of integral and purpose-driven recognition, i.e. hypotheses about the structure of a part of a sentence are verified based on hypotheses about the structure of the whole sentence. This obviates the need to analyze numerous parsing anomalies or variants.

The analysis methods are now described, in accordance with one exemplary implementation. Referring to FIG. **1**, there is shown a method **100** for preprocessing source sentences **112** in a source natural language prior to search. At step **110**, the source sentences are analyzed using linguistic descriptions useful for analyzing the source sentence. The linguistic descriptions may include morphological descriptions, syntactic descriptions, lexical descriptions, and semantic descriptions. In one implementation, a plurality of linguistic models and knowledge about natural languages may be arranged in a database and applied for analyzing each source sentence. Such a plurality of models could include a morphology model, a syntax model a grammar model and a lexical-semantic model. In a particular implementation, integral models for describing the syntax and semantics of the source language are used in order to recognize the meanings of the source sentence, analyze complex language structures, and correctly convey information encoded in the source sentence.

When analyzing the meaning of the source sentence, a two-step analysis algorithm (e.g., rough syntactic analysis and precise syntactic analysis) may be implemented to make use of linguistic models and knowledge at various levels, to calculate probability ratings and to generate the most probable syntactic structure, e.g., a best syntactic structure.

Accordingly, a rough syntactic analysis is performed on the source sentence to generate a graph of generalized constituents for further syntactic analysis. All the possible surface syntactic models for each element of lexical-morphological structure are applied, and all the possible constituents are built and generalized to represent all the possible variants of parsing the sentence syntactically. FIG. **2** illustrates an example of a graph of generalized constituents obtained as a result of rough syntactic analysis of the sentence "This boy is smart, he'll succeed in life."

Following the rough syntactic analysis, a precise syntactic analysis is performed on the graph of generalized constituents to generate one or more syntactic trees to represent the source sentence. In one implementation, generating the syntactic tree comprises choosing between lexical options and choosing between relations from the graphs. Many prior and statistical ratings may be used during the process of choosing between lexical options, and in choosing between relations from the graph. The prior and statistical ratings may also be used for assessment of parts of the generated tree and for the whole tree. In one implementation, the one or more syntactic trees may be generated in order of decreasing assessment. Thus, the best syntactic tree may be generated first. Non-tree links are also checked and generated for each syntactic tree at this time. If the first generated syntactic tree fails, for example, because of impossibility to establish non-tree links, the second syntactic tree is taken as the best, etc. FIG. **3** shows an example of a syntactic tree **300**, obtained as a result of precise syntactic analysis of the sentence "This boy is smart, he'll succeed in life." This tree contains complete syntactic information, such as lexical meanings, parts of speech, syntactic roles, grammatical values, syntactic relations (slots), syntactic models, non-tree link types, etc.

This novel two-step syntactic analysis approach ensures that the meaning of the source sentence is accurately represented by the best syntactic structure chosen from the one or more syntactic trees. Advantageously, the two-step analysis approach follows a principle of integral and purpose-driven recognition, i.e., hypotheses about the structure of a part of a sentence are verified using all available linguistic descriptions within the hypotheses about the structure of the whole sentence. This approach avoids a need to analyze numerous parsing anomalies or variants known to be invalid.

With reference to FIG. **1**, at step **120**, after the source sentence is analyzed, the syntactic structure of the sentence is semantically interpreted, and a language-independent semantic structure is constructed to represent the meaning of the source sentence. The language-independent semantic structure is a generalized data structure in language-independent form or format. Such a novel language-independent semantic structure is generated for each source sentence to accurately describe the meaning of the source sentence. The novel language-independent semantic structure can be applied to various applications, including, but not limited to, automated abstracting, machine translation, control systems, information retrieval or search, etc.

The disclosed analysis methods ensure that the maximum accuracy in conveying or understanding the meanings of the source sentence is achieved. FIG. **4** shows an example of a semantic structure, obtained for the sentence "This boy is smart, he'll succeed in life." This structure contains all syntactic and semantic information, such as semantic class, semantemes, semantic relations (deep slots), etc.

FIG. **5** illustrates a method to convert a source sentence into a language independent semantic structure through various structures according to an exemplary implementation of the invention and the linguistic descriptions employed. A lexical-morphological structure **522** is created from a source sentence (each source sentence in a corpora). A graph of generalized constituents is created **532**. Next, one or more syntactic trees is created **542**. A best syntactic structure is selected **546**. If a best one is not found, the method iterates until a best syntactic structure is identified (or until the system and method are exhausted of possibilities). Once a best syntactic structure is identified and selected, a language-independent semantic structure is created **552**. Indices are then generated.

FIG. **6** is a diagram illustrating language descriptions **610** according to one exemplary implementation of the technology. With reference to FIG. **6**, language descriptions **610** comprise morphological descriptions **501**, syntactic descriptions **502**, lexical descriptions, **503** and semantic descriptions **504**. Language descriptions **610** are joined into one common concept. The core of the language descriptions **610** is a semantic hierarchy, which links together language-independent semantic descriptions **504** and language-specific (1) lexical descriptions **503**, (2) morphological descriptions **501**, and (3) syntactic descriptions **502** for each language.

Semantic hierarchy may include semantic notions or semantic entities referred to herein as "semantic classes". The semantic classes may be arranged into a sematic hierarchy comprising hierarchical parent-child relationships. In general, a child semantic class inherits most properties of its direct parent and all ancestral semantic classes. For example, semantic class SUBSTANCE is a child of semantic class ENTITY and at the same time it is a parent of semantic classes GAS, LIQUID, METAL, WOOD MATERIAL, etc.

Each semantic class in the semantic hierarchy is supplied with a deep model. The deep model of the semantic class is a set of the deep slots. Deep slots reflect the semantic roles of child constituents in various sentences with objects of the semantic class as the core of a parent constituent and the possible semantic classes as fillers of deep slots. The deep slots express semantic relationships between constituents,

including, for example, "agent", "addressee", "instrument", "quantity", etc. A child semantic class inherits and adjusts the deep model of its direct parent semantic class.

Semantic descriptions **504** are language-independent. Semantic descriptions **504** may provide descriptions of deep constituents, and may comprise a semantic hierarchy, deep slots descriptions, a system of semantemes, and pragmatic descriptions.

FIG. **9** is a diagram illustrating semantic descriptions according to one exemplary implementation of the technology. Deep slots **914** reflect the semantic roles of child constituents in the deep models **912**. The deep slots descriptions **920** also contain grammatical and semantic restrictions on possible fillers of the deep slots. The properties and restrictions for the deep slots **914** and their possible fillers are very similar and oftentimes identical among different languages.

A system of semantemes represents a set of semantic categories. As an example, a semantic category "DegreeOfComparison" can be used to describe the degrees of comparison expressed by various forms of adjectives, for example, "easy", "easier" and "easiest". So, the semantic category "DegreeOfComparison" may include such semantemes as, for example, "Positive", "ComparativeHigherDegree", "SuperlativeHighestDegree", among others. As another example, a semantic category "RelationToReferencePoint" can be used to describe an order as before or after a reference point relative to some event or object, etc., and its semantemes may include, "Previous", "Subsequent", and the order may be spatial or temporal in a broad sense. As yet another example, "EvaluationObjective", as a semantic category, may describe an objective assessment, such as "Bad", "Good", etc.

The systems of semantemes include language-independent semantic attributes that express semantic characteristics as well as stylistic, pragmatic and communicative characteristics. Semantemes can also be used to express an atomic meaning that finds a regular grammatical and/or lexical expression in a language. By purpose and usage, semantemes may be divided into various kinds, including, but not limited to, grammatical semantemes, lexical semantemes, and classifying grammatical (differentiating) semantemes.

Grammatical semantemes **932** are used to describe grammatical properties of constituents when transforming a syntactic tree (a language dependent object) into a semantic structure. Lexical semantemes **934** describe specific properties of objects (for example, "being flat" or "being liquid") and are used in the deep slot descriptions **920** as restriction for deep slot fillers (for example, for the verbs "face (with)" and "flood", respectively). Classifying grammatical (differentiating) semantemes **936** express differentiating properties of objects within a single semantic class. For example, in the semantic class "HAIRDRESSER" the semanteme <<RelatedToMen>> is assigned to the lexical meaning "barber", unlike other lexical meanings which also belong to this class, such as "hairdresser", "hairstylist", etc.

Pragmatic descriptions **940** are used to assign a corresponding theme, style or genre to texts and objects of the semantic hierarchy. For example, "Economic Policy", "Foreign Policy", "Justice", "Legislation", "Trade", "Finance", etc.

With reference to FIG. **5**, the morphological descriptions **501**, the lexical descriptions **503**, the syntactic descriptions **502**, and the semantic descriptions **504** may be related. A lexical meaning may have one or more surface (syntactic) models that may be provided by semantemes and pragmatic characteristics. The syntactic descriptions **502** and the semantic descriptions **504** are also related. For examples, diatheses of the syntactic descriptions **502** can be considered as the "interface" between the language-specific surface models and language-independent deep models of the semantic description **504**.

FIG. **7** illustrates exemplary morphological descriptions **501**. As shown, the components of the morphological descriptions **501** include, but are not limited to, word-inflexion description **710**, grammatical system (e.g., grammemes) **720**, and word-formation description **730**. In one embodiment, grammatical system **720** includes a set of grammatical categories, such as, "Part of speech", "Case", "Gender", "Number", "Person", "Reflexivity", "Tense", "Aspect", etc. and their meanings, hereafter referred to as "grammemes". For example, part of speech grammemes may include "Adjective", "Noun", "Verb", etc.; case grammemes may include "Nominative", "Accusative", "Genitive", etc.; and gender grammemes may include "Feminine", "Masculine", "Neuter", etc.

Word-inflexion description **710** describes how the main form of a word form may change according to its case, gender, number, tense, etc. and broadly includes all possible forms for a given word. Word-formation **730** describes which new words may be generated involving a given word. The grammemes are units of the grammatical systems **720** and, as shown by a link **722** and a link **724**, the grammemes can be used to build the word-inflexion description **710** and the word-formation description **730**.

FIG. **8** illustrates exemplary syntactic descriptions **502**. The components of the syntactic descriptions **502** may comprise surface models **810**, surface slot descriptions **820**, referential and structural control descriptions **856**, government and agreement descriptions **840**, non-tree syntax descriptions **850**, and analysis rules **860**. The syntactic descriptions **502** are used to construct possible syntactic structures of a source sentence from a given source language, taking into account free linear word order, non-tree syntactic phenomena (e.g., coordination, ellipsis, etc.), referential relationships, and other considerations.

FIG. **10** is a diagram illustrating lexical descriptions **503** according to one exemplary implementation of the technology. The lexical descriptions **503** include a Lexical-Semantic Dictionary **1004** that contains a set of lexical meanings **1012** arranged with their semantic classes into a Semantic hierarchy, where each lexical meaning **1012** may include, but is not limited to, its deep model **912**, surface model **810**, grammatical value **1008** and semantic value **1010**.

Returning to FIG. **1**, at step **130**, after the language-independent semantic structure is constructed, then a syntactic structure and a language-independent semantic structure are indexed. Each parameter of the morphological, syntactic, lexical, and semantic descriptions can be indexed in the same fashion as each word in a document is indexed. An index usually comprises a table where each word (each lexeme or word form) in a document is accompanied by a list of numbers or addresses of its occurrences in that document. According to implementations described herein, an index is produced to index all values of morphological, syntactic, lexical, and semantic parameters. These parameters values are generated during the two-stage semantic analysis described above. The index may be used to facilitate semantic searching of the natural language source text. Thus, for example, a user may search for all sentences containing nouns with the property "being flat" or "being liquid", or all sentences containing nouns or verbs denoting processes of creating something, or destructing, or moving, etc.

Combinations of two, three, or, generally, combinations of n numbers can be used to index various syntactic, semantic or other parameters. For example, to index surface or deep slots,

for each slot, combinations of two numbers of words that are linked by the relationship corresponding to these slots can be used. For example, referring to the example of FIG. **4** of a semantic structure obtained for the sentence "This boy is smart, he'll succeed in life", the deep slot 'Sphere' (**450**) relates the lexical meaning succeed:TO_SUCCEED (**460**) with the lexical meaning life:LIVE (**470**). More particularly, life:LIVE fills the deep slot 'Sphere' of the verb succeed: TO_SUCCEED. When the index of lexical meanings is built, in accordance with the techniques disclosed herein, these occurrences of the lexical meanings are assigned numbers based on the position of the occurrences within the document, for example, N1 and N2, respectively. When the index of deep slots is built, every deep slot has a corresponding list of occurrences in the document. For example, the index of the deep slot 'Sphere' will include the pair (N1, N2), among others.

Since not only words are indexed, but semantic classes, syntactic and semantic relations, any other elements of syntactic and semantic structures too, it becomes possible to search contexts including not only words, but also contexts including lexical meanings, semantic classes, contexts including words having the same syntactic features or/and semantic features or/and morphological features or a sets of such features. Additionally, sentences with non-tree syntax phenomena, for example, ellipsis, coordination etc. may be found. Since it possible to search semantic classes, sets of semantically associated words and notions may be found.

It is also possible to find fragments of syntactic and/or semantic structures. The results of searching may be sentences or paragraphs, or any other fragments as a user wants and selects the corresponding option. Since all sentences in corpora are analyzed and saved with all results of their syntactic and semantic analyses, the syntactic and/or semantic structures of the found sentences may be graphically shown to a user.

FIG. **11** shows an example of a search system graphical user interface that allows a user to formulate queries using semantic relations and lexical meanings that belong to a certain semantic class. An example of a query is shown in FIG. **11**, and answers the question "What countries were discovered?" In terms of a semantic query in window **1110**, the query appears as "discover [Object:"COUNTRY"]", and means that the semantic search system will search sentences with the verb "discover" and the object that belongs to the semantic class COUNTRY. Results of the search are shown in a search results window **1120**.

Another example of a query is shown in FIG. **12**, it answers the question "What can be made from milk?" In terms of a semantic query, in window **1210** the query appears as "CREATION_VERBS" [Object:<Noun>, Fabricative: milk]", where "CREATION_VERBS" is a semantic class of verbs denoting process of creation, such as "to make", "to produce", "to manufacture", "to confect" etc. Any of these and other verbs belonging to the semantic class "CREATION_VERBS" may be found in required sentences. "Fabricative" is a semantic role (semantic slot) that means "raw material", material from which something us produced. In this case, such "raw material" is milk. So, the result must be a <Noun> and it must fill the semantic slot "Object" in sentences. Results of the search are shown in a search results window **1220**.

Yet another example of a query to the semantic search system is shown in FIG. **13**. The question is: "What do the people collect?" In terms of a semantic query, in window **1310**, the query appears as "collect[$Subject:people, $Object_Direct:<Noun>]". The semantic search system searches sentences with the verb "collect" and the word "people" that fills the surface slot "Subject". The goal of the search is a noun (or nouns) in the role of the direct object of the verb "collect". Results of search are shown in a search results window **1320**.

FIG. **13**A shows still another example of query using a variable for denoting "lacunas" in searched sentences and a possibility of selecting one or more multi-language or multilingual corpora of texts. In this implementation, such variable, for example, [$Subject: [. . . [people]]] is used for describing searched sentences comprising a noun group with the core "people" filling a syntactic (surface) slot "Subject" and the verb "think" in any form.

In one implementation of the invention, all morphological forms of words involved in queries are taken into account, and all morphological forms of words may be found. The restrictions on morphological forms of words involved in queries and searched morphological forms may be specified as a restriction on grammatical values and is shown in, for example, brackets < >.

The index produced in accordance with the techniques may be provisioned as part of a semantic search system, in accordance with one implementation of the invention.

Implementations of the present invention also disclose a semantic search technique wherein a user can formulate a question in a natural language. The same analysis techniques are then used to analyze the question, recognize its syntactical structure, and build its semantic structure, thereby "understanding" the meaning of the sentence. The constructed semantic structure is then translated into a query language for the semantic search system.

Additionally, since the search query may be expressed or translated into semantic language-independent terms, the search may be executed in various languages, in resources of various languages, in text corpora of various languages. So, a user can get information that is presented in all resources regardless of the language of the query. The result of searching may be presented to users in a resource language (as it is presented in the resource), and also the result of searching may be translated into the language of the query by means of a machine translation system.

FIG. **14** shows exemplary hardware for implementing the techniques and systems described herein, in accordance with one implementation of the present disclosure. Referring to FIG. **14**, the exemplary hardware **1400** includes at least one processor **1402** coupled to a memory **1404**. The processor **1402** may represent one or more processors (e.g. microprocessors), and the memory **1404** may represent random access memory (RAM) devices comprising a main storage of the hardware **1400**, as well as any supplemental levels of memory, e.g., cache memories, non-volatile or back-up memories (e.g. programmable or flash memories), read-only memories, etc. In addition, the memory **1404** may be considered to include memory storage physically located elsewhere in the hardware **1400**, e.g. any cache memory in the processor **1402** as well as any storage capacity used as a virtual memory, e.g., as stored on a mass storage device **1410**.

The hardware **1400** also typically receives a number of inputs and outputs for communicating information externally. For interface with a user or operator, the hardware **1400** may include one or more user input devices **1406** (e.g., a keyboard, a mouse, imaging device, scanner, microphone) and a one or more output devices **1408** (e.g., a Liquid Crystal Display (LCD) panel, a sound playback device (speaker)). To embody the present invention, the hardware **1400** typically includes at least one screen device.

For additional storage, the hardware **1400** may also include one or more mass storage devices **1410**, e.g., a floppy or other removable disk drive, a hard disk drive, a Direct Access Storage Device (DASD), an optical drive (e.g. a Compact Disk (CD) drive, a Digital Versatile Disk (DVD) drive) and/or a tape drive, among others. Furthermore, the hardware **1400** may include an interface with one or more networks **1412** (e.g., a local area network (LAN), a wide area network (WAN), a wireless network, and/or the Internet among others) to permit the communication of information with other computers coupled to the networks. It should be appreciated that the hardware **1400** typically includes suitable analog and/or digital interfaces between the processor **1402** and each of the components **1404**, **1406**, **1408**, and **1412** as is well known in the art.

The hardware **1400** operates under the control of an operating system **1414**, and executes various computer software applications, components, programs, objects, modules, etc. to implement the techniques described above. Moreover, various applications, components, programs, objects, etc., collectively indicated by application software **1416** in FIG. **14**, may also execute on one or more processors in another computer coupled to the hardware **1400** via a network **1412**, e.g. in a distributed computing environment, whereby the processing required to implement the functions of a computer program may be allocated to multiple computers over a network.

In general, the routines executed to implement the embodiments of the invention may be implemented as part of an operating system or a specific application, component, program, object, module or sequence of instructions referred to as a "computer program." A computer program typically comprises one or more instruction sets at various times in various memory and storage devices in a computer, and that, when read and executed by one or more processors in a computer, cause the computer to perform operations necessary to execute elements involving the various aspects of the invention. Moreover, while the invention has been described in the context of fully functioning computers and computer systems, those skilled in the art will appreciate that the various embodiments of the invention are capable of being distributed as a program product in a variety of forms, and that the invention applies equally to actually effect the distribution regardless of the particular type of computer-readable media used. Examples of computer-readable media include but are not limited to recordable type media such as volatile and non-volatile memory devices, floppy and other removable disks, hard disk drives, optical disks (e.g., Compact Disk Read-Only Memory (CD-ROMs), Digital Versatile Disks (DVDs), flash memory, etc.), among others. Another type of distribution may be implemented as Internet downloads.

While certain exemplary embodiments have been described and shown in the accompanying drawings, it is to be understood that such embodiments are merely illustrative and not restrictive of the broad invention and that this invention is not limited to the specific constructions and arrangements shown and described, since various other modifications may occur to those ordinarily skilled in the art upon studying this disclosure. In an area of technology such as this, where growth is fast and further advancements are not easily foreseen, the disclosed embodiments may be readily modified or re-arranged in one or more of its details as facilitated by enabling technological advancements without departing from the principals of the present disclosure.

The invention claimed is:

1. A computer-implemented method for facilitating a semantic search, the method comprising:

identifying a corpora of natural language texts including a plurality of sentences;

performing a syntactic-semantic analysis on each sentence of the plurality of sentences using a linguistic description associated with a language of the sentence, wherein the syntactic-semantic analysis comprises:

generating a graph of generalized constituents for each sentence of the plurality of sentences; and

generating one or more syntactic trees based on the graphs of generalized constituents to represent the corresponding sentences;

generating at least one syntactic structure for each sentence of the plurality of sentences by selecting a best syntactic tree from the generated one or more syntactic trees to represent the at least one syntactic structure of the sentence;

generating a semantic structure for each sentence of the corpora of natural language texts, based on the generated at least one syntactic structure of the sentence, wherein the semantic structure is language independent and wherein the semantic structure comprises semantic classes, semantemes, deep slots, and non-tree links;

associating the generated syntactic structures and the generated semantic structures with the respective sentences;

creating syntactic index for each meaning of at least one linguistic parameter of each of the generated syntactic structures;

creating a semantic index for each meaning of at least one parameter of the semantic structures;

receiving a search query comprising semantic language-independent terms;

searching the semantic index based on the semantic language-independent terms and the language-independent semantic structures; and

receiving semantic search results from the semantic index, wherein the search results from the corpora of natural language texts includes sentences in different languages.

2. The computer-implemented method of claim **1**, wherein the performing the syntactic-semantic analysis includes resolving an ambiguity of lexical unit meanings within at least one of the sentences of the corpora of natural language texts.

3. The computer-implemented method of claim **1**, wherein each sentence includes one or more language-specific properties, and wherein generating the language independent semantic structure comprises encoding each language-specific property with a language-independent parameter.

4. The computer-implemented method of claim **3**, wherein the method further comprises indexing at least one meaning of each language-independent parameter.

5. The computer-implemented method of claim **1**, wherein the search is performed in a corpora of natural language texts of different languages.

6. The computer-implemented method of claim **1**, wherein the semantic search results are received in a source language.

7. The computer-implemented method of claim **1**, wherein the method further comprises indexing combinations of two or more meanings of syntactic parameters.

8. The computer-implemented method of claim **1**, wherein the method further comprises indexing combinations of two or more meanings of semantic parameters.

9. The computer-implemented method of claim **1**, wherein the method further comprises:

performing a search query and sending a search result based at least in part upon the syntactic index.

10. The computer-implemented method of claim **1**, wherein the method further comprises:

performing a search query and sending a search result based at least in part upon the semantic index.

11. The computer-implemented method of claim 1, where the linguistic description includes at least a semantic description, a syntactic description, a lexical description, and a morphological description.

12. The computer-implemented method of claim 11, wherein the method further comprises generating an overall index from:

at least one value of a semantic parameter associated with the semantic description,

at least one value of the syntactic parameter associated with the syntactic description,

at least one value of a lexical parameter associated with the lexical description, and

at least one value of a morphological parameter associated with the morphological description.

13. The computer-implemented method of claim 12, wherein the syntactic parameter may include a syntactic relation.

14. The computer-implemented method of claim 12, wherein the semantic parameter may include a semantic relation.

15. A computer-implemented method for providing a result of a search, the method comprising:

for each sentence of a corpus of texts, the corpus of texts including a plurality of sentences, generating at least one syntactic structure for each sentence of the plurality of sentences, using at least one linguistic description associated with a source natural language by performing a syntactic-semantic analysis of the sentences comprising:

generating graph of generalized constituents for each sentence of the plurality of sentences;

generating one or more syntactic trees based on the graphs of generalized constituents to represent the corresponding sentences; and

selecting a best syntactic tree from the generated one or more syntactic trees to represent the at least one syntactic structure;

building a language-independent semantic structure for each said sentence based on the at least one syntactic structure of the sentence, wherein the semantic structure comprises semantic classes, semantemes, deep slots, and non-tree links;

associating each generated syntactic structure and each language independent semantic structure with a respective sentence;

indexing at least one meaning of linguistic parameters associated with each sentence;

indexing at least one lexical meaning associated with each lexical unit of each sentence;

indexing at least one value associated with linguistic parameters related to a syntactic structure of each sentence;

indexing at least one value associated with semantic parameters related to the language-independent semantic structure of each sentence; and

receiving a search query comprising semantic language-independent terms;

searching the index of at least one value associated with semantic parameters based on the semantic language-independent terms and the language-independent semantic structures; and

receiving semantic search results from the index of at least one value associated with semantic parameters, wherein the search results include sentences from the corpus of text in different languages.

16. The computer-implemented method of claim 15, wherein the searching includes resolving an ambiguity of lexical unit meanings within at least one of the sentences of the corpus of text.

17. The computer-implemented method of claim 15, wherein the language-independent semantic structure for each said sentence includes a stylistic characteristic, a pragmatic characteristic or a communicative characteristic.

18. The computer-implemented method of claim 15, wherein the performing the search includes translating a query term into a semantic language-independent query term.

19. A system for facilitating a semantic search, the system comprising:

a first processor and a computer readable memory;

a corpus of natural language texts including a plurality of sentences;

an analyzer in the computer readable memory configured to:

perform a syntactic-semantic analysis on each sentence of the plurality of sentences using a linguistic description associated with a language of the sentence wherein the syntactic-semantic analysis comprises:

generating a graph of generalized constituents for each sentence of the plurality of sentences; and

generating one or more syntactic trees based on the graphs of generalized constituents to represent the corresponding sentences;

generating at least one syntactic structure for each sentence of the plurality of sentences by selecting a best syntactic tree from the generated one or more syntactic trees to represent the at least one syntactic structure of the sentence;

generating a semantic structure for each sentence of the corpus of natural language texts, based on the generated at least one syntactic structure of the sentence, wherein the semantic structure is language independent and wherein the semantic structure comprises semantic classes, semantemes, deep slots, and non-tree links; and

associate the generated syntactic structures and the generated semantic structures with the respective sentences;

an index generation component configured to:

create a syntactic index for each meaning of at least one linguistic parameter of the generated syntactic structures; and

create a semantic index for each meaning of at least one parameter of the language independent semantic structures;

and

the first processor configured to:

receive a search query comprising semantic language-independent terms;

search the semantic index of at least one value associated with semantic parameters based on the semantic language-independent terms and the language-independent semantic structures; and

receive semantic search results from the semantic index of at least one value associated with semantic parameters, wherein the search results include sentences from the corpus of text in different languages.

20. The system of claim 19, wherein to perform the syntactic-semantic analysis the analyzer is configured to resolve an ambiguity of lexical unit meanings within at least one of the sentences of the corpus of natural language texts.

21. The system of claim 20, wherein each sentence includes a language-specific property, wherein the generating

the language independent semantic structure includes encoding the language-specific property with a language-independent parameter.

22. The system of claim **21**, wherein the index generation component is further configured to index at least one meaning of each language-independent parameter.

23. The system of claim **19**, wherein the search may be performed in a corpus of natural language texts of different languages.

24. The system of claim **19**, wherein the semantic search result is sent in a source language.

25. The system of claim **19**, wherein the index generation component is further configured to index a meaning of each sentence.

26. The system of claim **19**, wherein the index generation component is further configured to index combinations of two or more meanings of syntactic parameters.

27. The system of claim **19**, wherein the index generation component is further configured to index combinations of two or more meanings of semantic parameters.

28. The system of claim **19**, wherein the first processor is further configured to: after each generated syntactic structure and the language independent semantic structure for each sentence of the corpus of natural language text is stored, perform a search query and send a search result based at least in part upon the syntactic index.

29. The system of claim **19**, where each linguistic description includes at least a semantic description, a syntactic description, a lexical description, and a morphological description.

30. The system of claim **29**, wherein the index generation component is further configured to generate an overall index from:

at least one value of a semantic parameter associated with the semantic description,

at least one value of the syntactic parameter associated with the syntactic description,

at least one value of a lexical parameter associated with the lexical description, and

at least one value of a morphological parameter associated with the morphological description.

31. The system of claim **30**, wherein the syntactic parameter may include a syntactic relation.

32. The system of claim **30**, wherein the semantic parameter may include a semantic relation.

33. One or more non-transitory computer-readable media having computer-executable instructions, which when executed perform steps, comprising:

instructions for identifying a corpus of natural language texts including a plurality of sentences;

instructions for performing a syntactic-semantic analysis on each sentence of the plurality of sentences using a linguistic description associated with a language of the sentence, wherein the syntactic-semantic analysis comprises:

generating graph of generalized constituents for each sentence of the plurality of sentences; and

generating one or more syntactic trees based on the graphs of generalized constituents to represent the corresponding sentences;

generating at least one syntactic structure for each sentence of the plurality of sentences by selecting a best syntactic tree from the generated one or more syntactic trees to represent the at least one syntactic structure of the sentence;

generating a semantic structure for each sentence of the corpus of natural language texts, wherein the semantic structure is language independent and wherein the semantic structure comprises semantic classes, semantemes, deep slots, and non-tree links;

instructions for associating the language independent semantic structure with a respective sentence;

instructions for creating a syntactic index for each meaning of at least one linguistic parameter of the generated syntactic structures;

instructions for creating a semantic index for each meaning of at least one parameter of the language independent semantic structures;

instructions for receiving a search query comprising semantic language-independent terms;

instructions for searching the semantic index of at least one value associated with semantic parameters based on the semantic language-independent terms and the language-independent semantic structures; and

instructions for receiving semantic search results from the semantic index of at least one value associated with semantic parameters, wherein the search results include sentences from the corpus of text in different languages.

34. The one or more non-transitory computer-readable media of claim **33**, wherein the instructions for performing the syntactic-semantic analysis include instructions for resolving an ambiguity of lexical unit meanings within at least one of the sentences of the corpus of natural language texts.

35. The one or more non-transitory computer-readable media of claim **33**, wherein each sentence includes a language-specific property, wherein generating the language independent semantic structure includes encoding the language-specific property with a language-independent parameter.

36. The one or more non-transitory computer-readable media of claim **33**, wherein the computer-executable instructions further comprise instructions for indexing at least one meaning of each language-independent parameter.

37. The one or more non-transitory computer-readable media of claim **33**, wherein the search may be performed in a corpus of natural language texts of different languages.

38. The one or more non-transitory computer-readable media of claim **33**, wherein the semantic search result is sent in a source language.

39. The one or more non-transitory computer-readable media of claim **38**, wherein the instructions further comprise indexing a meaning of each sentence.

40. The one or more non-transitory computer-readable media of claim **33**, wherein the instructions further comprise indexing combinations of two or more meanings of syntactic parameters.

41. The one or more non-transitory computer-readable media of claim **33**, wherein the instructions further comprise indexing combinations of two or more meanings of semantic parameters.

42. The one or more non-transitory computer-readable media of claim **33**, wherein the instructions further comprise:

performing a search query and sending a search result based at least in part upon the syntactic index.

43. The one or more non-transitory computer-readable media of claim **33**, where each linguistic description includes at least a semantic description, a syntactic description, a lexical description, and a morphological description.

44. The one or more non-transitory computer-readable media of claim **43**, wherein the instructions further comprise instructions for generating an overall index from:

at least one value of a semantic parameter associated with the semantic description,

at least one value of the syntactic parameter associated with the syntactic description,

at least one value of a lexical parameter associated with the lexical description, and

at least one value of a morphological parameter associated with the morphological description.

45. The one or more non-transitory computer-readable media of claim **44**, wherein the syntactic parameter may include a syntactic relation.

46. The one or more non-transitory computer-readable media of claim **44**, wherein the semantic parameter may include a semantic relation.

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